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Table of Contents

SYSTEMATICS

Supplemental notes on Bolivian **Xyris** (Xyridaceae)
Robert Kral 563

Two new Bolivian species of **Aulonemia** (Poaceae: Bambusoideae: Bambuseae)
Emmet J. Judziewicz, Eddie L. Shea, and Tanya M. Wayda 569

A new **Leucophyllum** (Scrophulariaceae) from Sonora, Mexico
James Henrickson and Thomas R. Van Devender 581

Poa ramifer (Poaceae: Pooideae: Poeae: Poinae), a new aerially branching gynomonoecious species from Peru
Robert J. Soreng and Paul M. Peterson 587

Two new Andean species of **Solanum** section **Crinitum** (Solanaceae)
Frank T. Farruggia, Michael H. Nee, and Lynn Bohs 595

A new species of **Campomanesia** (Myrtaceae) from Bahia, Brazil, based on specimens collected by J.S. Blanchet over 150 years ago
Leslie R. Landrum and Marla Ibrahim U. de Oliveira 603

Folia taxonomica 18. The status of **Passiflora citrifolia** and a new species in subgenus **Astrophea** (Passifloraceae), **Passiflora jussieui**
Christian Feuillet 609

Folia taxonomica 19. Typifications in **Dilkea** (Passifloraceae)
Christian Feuillet 615

Taxonomic notes on the genera **Stenotis** and **Carterella** (Rubiaceae) and transfer of **Hedyotis greenei** to **Stenotis**
Edward E. Terrell and Harold Robinson 619

Transfer of **Hedyotis intricata** to **Arcytophyllum** (Rubiaceae)
Edward E. Terrell and Harold Robinson 625

Nomenclatural transfers in the genus **Myrsine** (Myrsinaceae) for New Caledonia
Jon M. Ricketson and John J. Pipoly III 627

Hedychium forrestii (Zingiberaceae) with a new synonymy and a variety from India
E. Sanoj, M. Sabu, and T. Rajesh Kumar 633

The reinstatement of **Ptilimnium texense** (Apiaceae) and a new key to the genus
Mary Ann E. Feist 641

A new variety of **Bromus flexuosus** (Poaceae: Pooideae: Bromeae: sect. Bromopsis)
Ana María Planchuelo 653

The genus **Rytidosperma** (Poaceae) in the United States of America
Stephen J. Darbyshire, Henry E. Connor, and Barbara Ertter 663

Typifications of names in **Agalinis, Gerardia,** and **Tomanthera** (Orobanchaceae)
J.M. Canne-Hilliker and John F. Hays 677

A new combination in **Lolium perenne** (Poaceae: Poeae); **L. perenne** subsp. **stoloniferum**
Joseph K. Wipff, III 683

Paleocharis nearctica gen. and sp. nov (Cyperaceae) in Cretaceous Canadian amber
George O. Poinar, Jr. and David J. Rosen 685

Coleataenia Griseb. (1879): the correct name for **Sorengia** Zuloaga & Morrone (2010) (Poaceae: Paniceae)
ROBERT J. SORENG **691**

Congruence between allometric coefficients and phylogeny in stipoid grasses: an evo-devo study
JACK MAZE **693**

Thomas Walter's species of **Hedysarum** (Leguminosae)
DANIEL B. WARD **705**

FLORISTICS, ECOLOGY, AND CONSERVATION

Listado florístico y aspectos ecológicos de la familia Poaceae para Chihuahua, Durango y Zacatecas, México
YOLANDA HERRERA ARRIETA Y ARMANDO CORTÉS ORTIZ **711**

Mirandea grisea (Acanthaceae), new for Coahuila and Durango, Mexico
EDUARDO ESTRADA-CASTILLÓN, JOSÉ ÁNGEL VILLARREAL-QUINTANILLA, AND JORGE ARTURO ALBA-ÁVILA **739**

Registro de dos nuevas localidades y reubicación de individuos de una de ellas de **Astrophytum myriostigma** (Cactaceae) en Durango, México
JAIME SÁNCHEZ SALAS, GISELA MURO PÉREZ, EDUARDO ESTRADA CASTILLÓN Y MARIO GARCÍA ARANDA **741**

Erigeron mancus (Asteraceae) density as a baseline to detect future climate change in La Sal Mountain habitats
JAMES F. FOWLER AND BARB SMITH **747**

Scallopleaf sage (**Salvia vaseyi:** Lamiaceae) discovered in Arizona
JAMES W. CAIN, III, BRIAN D. JANSEN, RICHARD S. FELGER, AND PAUL R. KRAUSMAN **755**

Paspalum pubiflorum and **P. quadrifarium** (Poaceae) new to California, with a key and notes on invasive species
RICHARD E. RIEFNER, JR., SILVIA S. DENHAM, AND J. TRAVIS COLUMBUS **761**

Sarracenia minor var. **okefenokeensis** (Sarraceniaceae) discovered outside of the Okefenokee Swamp area
JACOB S. THOMPSON **771**

Polycarpon tetraphyllum (Caryophyllaceae) new to the flora of Louisiana
CHARLES M. ALLEN, JARROD GRANDON, KRISZTIAN MEGYERI, AND BRAD WAGUESPACK **775**

Additions to the vascular flora of New Mexico
BEN S. LEGLER **777**

Book Reviews and Notices 568, 580, 586, 608, 618, 624, 640, 652, 682, 746, 754, 774, 776, 785

Announcements 786

Reviewers for Volume 4 (2010)—**787**
Index to Volume 4 (2010)
Titles of Articles with Authors—**788**
Authors—**791**
Botanical Names and Subjects—**792**
New Names and Combinations—**798**

INDEX to new names and new combinations in *J. Bot. Res. Inst. Texas* 4(2), 2020

Arcytophyllum fasciculatum (A. Gray) Terrell & H. Rob., comb. nov.—**625**
Aulonemia bromoides Judz. & Shea, sp. nov.—**570**
Aulonemia scripta Judz. & Wayda, sp. nov.—**573**
Bromus flexuosus var. **famatinensis** Planchuelo, var. nov.—**657**
Campomanesia blanchetiana Landrum & Ibrahim, sp. nov.—**604**
Coleataenia anceps (Michx.) Soreng, comb. nov.—**691**
Coleataenia anceps subsp. **rhizomata** (Hitchc. & Chase) Soreng, comb. nov.—**691**
Coleataenia caricoides (Nees ex Trin.) Soreng, comb. nov.—**691**
Coleataenia longifolia (Torr.) Soreng, comb. nov.—**691**
Coleataenia longifolia subsp. **abscissa** (Swallen) Soreng, comb. nov.—**691**
Coleataenia longifolia subsp. **combsii** (Scribner & C.R. Ball) Soreng, comb. nov.—**691**
Coleataenia longifolia subsp. **elongata** (Scribn.) Soreng, comb. nov.—**691**
Coleataenia longifolia subsp. **rigidula** (Bosc ex Nees) Soreng, comb. nov.—**691**
Coleataenia petersonii (Hitchc. & Ekman) Soreng, comb. nov.—**692**
Coleataenia prionitis (Nees) Soreng, comb. nov.—**692**
Coleataenia stenodes (Griseb.) Soreng, comb. nov.—**692**
Coleataenia tenera (Beyr. ex Trin.) Soreng, comb. nov.—**692**
Hedychium forrestii var. **palaniense** Sanoj & M. Sabu, var. nov.—**634**
Leucopyllum mojinense Henrickson & T.R. Van Devender, sp. nov.—**581**
Lolium perenne subsp. **stoloniferum** (C. Lawson) Wipff, comb. et stat. nov.—**683**
Myrsine albiflorens (M. Schmid) Ricketson & Pipoly, comb. nov.—**628**
Myrsine arborea (M. Schmid) Ricketson & Pipoly, comb. nov.—**628**
Myrsine asymmetrica (Mez) Ricketson & Pipoly, comb. nov.—**628**
Myrsine asymmetrica subsp. **magnifolia** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**628**
Myrsine asymmetrica subsp. **paniensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**628**
Myrsine asymmetrica subsp. **parvifolia** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**628**
Myrsine belepensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**629**
Myrsine boulindaensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**629**
Myrsine citrifolia (Mez) Ricketson & Pipoly, comb. nov.—**629**
Myrsine diminuta (Mez) Ricketson & Pipoly, comb. nov.—**629**
Myrsine discocarpa (M. Schmid) Ricketson & Pipoly, comb. nov.—**629**
Myrsine dumbeaensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**629**
Myrsine grandifolia (S. Moore) Ricketson & Pipoly, comb. nov.—**629**
Myrsine humboldtensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**629**
Myrsine katrikouensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**629**
Myrsine koghiensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**629**
Myrsine kuebiniensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**629**
Myrsine lanceolata subsp. **ouenarouensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**629**
Myrsine lecardii (Mez) Ricketson & Pipoly, comb. nov.—**629**
Myrsine macrophylla (Mez) Ricketson & Pipoly, comb. nov.—**630**
Myrsine macrophylla subsp. **menaziensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**630**
Myrsine mcphersonii (M. Schmid) Ricketson & Pipoly, comb. nov.—**630**
Myrsine memaoyaensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**630**
Myrsine modesta (Mez) Ricketson & Pipoly, comb. nov.—**630**
Myrsine modesta subsp. **coriaria** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**630**
Myrsine modesta subsp. **tiebaghiensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**630**
Myrsine munzingeri (M. Schmid) Ricketson & Pipoly, comb. nov.—**630**
Myrsine nigricans (M. Schmid) Ricketson & Pipoly, comb. nov.—**630**
Myrsine nigricans subsp. **ouinensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**630**
Myrsine nitens (M. Schmid) Ricketson & Pipoly, comb. nov.—**630**
Myrsine novocaledonica (Mez) Ricketson & Pipoly, comb. nov.—**630**
Myrsine novocaledonica subsp. **balabioensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**630**
Myrsine novocaledonica subsp. **boulindaensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**630**
Myrsine novocaledonica subsp. **kaalaensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**630**
Myrsine novocaledonica subsp. **mueoensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**630**
Myrsine novocaledonica subsp. **piroguensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**630**

Myrsine oblanceolata (M. Schmid) Ricketson & Pipoly, comb. nov.—**630**
Myrsine oblanceolata subsp. **doensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**631**
Myrsine obovalifolia (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine ouameniensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine ouazangouensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine ovicarpa (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine paniensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine parvicarpa (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine parvicarpa subsp. **amossensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**631**
Myrsine parvicarpa subsp. **pachyphylla** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**631**
Myrsine poumensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine pronyensis (Guillaumin) Ricketson & Pipoly, comb. nov.—**631**
Myrsine spissifolia (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine stenophylla (Mez) Ricketson & Pipoly, comb. nov.—**631**
Myrsine taomensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine tchingouensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine verrucosa (M. Schmid) Ricketson & Pipoly, comb. nov.—**631**
Myrsine verrucosa subsp. **microphylla** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**631**
Myrsine yateensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**632**
Paleocharis Poinar & D.J. Rosen, gen. nov.—**686**
Paleocharis nearctica Poinar & D.J. Rosen, sp. nov.—**687**
Passiflora jussieui Feuillet, sp. nov.—**611**
Poa ramifer Soreng & P.M. Peterson, sp. nov.—**587**
Solanum adenobasis M. Nee & Farruggia, sp. nov.—**598**
Solanum cyathophorum M. Nee & Farruggia, sp. nov.—**596**
Stenotis greenei (A. Gray) Terrell & H. Rob., comb. nov.—**622**
Xyris crassifunda Kral, sp. nov.—**563**
Xyris submetallica Kral, sp. nov.—**565**

SUPPLEMENTAL NOTES ON BOLIVIAN *XYRIS* (XYRIDACEAE)

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ABSTRACT

Examination of Bolivian material of Xyridaceae sent from the Missouri Botanical Garden for identification has shown two novelties in *Xyris* (**X. crassifunda, X. submetallica**). These are hereby described and illustrated and their relationships discussed.

RESUMEN

El examen de material boliviano de Xyridaceae enviado por el Missouri Botanical Garden para identificación ha mostrado dos novedades en *Xyris* (**X. crassifunda, X. submetallica**). Se describen e ilustran aquí y se discuten sus relaciones

Of the Bolivian Xyridaceae sent to me for determination from the Missouri Botanical Garden, two are distinct and are not found in existing treatments (Kral 1988, 1994; Maguire & Smith 1964; Smith & Downs 1968). These are presented below.

1. Xyris crassifunda Kral, sp. nov. (**Fig. 1**). TYPE: BOLIVIA. SANTA CRUZ. Velasco Prov.: Parque National Noel Kempff M. Los Fierros, a 500 m del ultimo arroyo, sobre el Camino a la meseta, bosque de galleria, suelos arcillosos, con arena y humus, 650 m, 14° 45'2"S, 60° 45'29.8"W, 26 Ago 1995, *R. Guillen, F. Mayle, F. Soliz & J. Surubi 4175* (HOLOTYPE: USZ; ISOTYPES: MO, VDB).

Planta perennis, caespitosa, juncea, (5–)6–7(–7.6) dm alta, basibus caudiciformis, lignosis, dilatatis, persistentes veternas foliorum obtectis. Caules incrassati, sublignosi. Folia principalia rigida, ascendentes vel erecta, flexuosa, 35–45 cm longa, vaginis scaporum longiora; vaginae integrae aut a basin ciliatae, laminis 4–5-plo breviora, prope basem castaneae vel rufobrunneolae, ecarinatae, sursum luteobrunneolae, transverse rugulosae aut rugosae, in laminas abrupte, tum gradatim decrescentes, ad apicum ligulatae, ligulae recta, 3–3.5 mm longa. Vaginae scaporum prope basin lamprobrunneolae, apicum versus apertae, brevilaminae. Scapi recti, flexuosi et torte, a basin lamprobrunneolae, sursum flavovirenti, 1–1.2 mm crassae, pauci et grosse costatae, transverse subtiliter vel manifesto undulato-rugulosae. Spicae obovoideae, 1–1.2 cm, pluriflorae; bracteis firmis, spiraliter imbricates, convexis, ecarinatis, atrorufobrunneolis, areis dorsalibus anguste ellipticis, pallide brunneolis, ca. 2 mm longis; bracteae steriles 3–4, ovatae vel obovatae aut oblongae, 5–6 mm longae; bracteae fertiles late obovatae vel oblongae, 6–7 mm longae, integris, turn erosis. Sepala lateralia libera, inaequilateralia, 7–7.5 mm longa, acuta; ala carinali curvata, a basin a medio ciliata, a medio ad apicem villosi-ciliata vel, ad apicem, fimbriata. Laminae petalorum ellipticae vel obovatae, ca. 7 mm longae, luteolae. Staminodia bibrachiata, brachiis 2 mm longis. Capsula anguste ellipsoidea, 5 mm longa; placenta basalis. Semina numerosa, ellipsoidea, longitudine grosse anastomoso-costata, rufobrunneola, ca. 1 mm longa.

Plants slender, rushlike, caespitose, hard-based, perennial, (5–)6–7(–7.6) dm high. Roots fibrous. Shoots short, stout, hard, close-set, arising from a ligneous, caudex-like base, stem bases often hidden by persistent, dark fibrils from old leaf bases. Principal leaves erect or ascending, flexuous and twisted, 35–45 cm long, longer than the scape sheaths; sheaths entire or basally ciliate, ⅕–¼ of blade length, the convex, several-carinate base of outer (lower) principal leaves, more dilated, often ciliate, more abruptly narrowed distally than those of the upper, all at very base castaneous or dark red-brown, smooth, upsheath becoming paler, transversely rugose or rugulose medially, the smooth, chartaceous borders gradually narrowed, apically converging to an acute ligule 3–3.5 mm long; blades narrowly linear, twisted and flexuous, 1–1.5 mm thick at level of ligule, gradually narrowed distally to a subulate-conic tip, coarsely and unevenly few-costate, costae making rounded angles, these and the uneven shallow sulcae yellow-green or tan, transversely finely papillose-rugulose. Scape sheaths firm, rounded-costate, yellow-green, papillose, conduplicate, smooth and red-brown proximally, open apically, the chartaceous edges converging as ligule, the apex projecting just beyond as a stubby, conic, apiculate blade. Scapes erect, twisted, proximally 2–2.5 mm thick and lustrous red-brown, distally narrowing to ca. 1.5 mm thick, coarsely low-costate, increasingly transversely rugulose-papillate, dull yellow-green. Mature spikes several-flowered, obovoid, 1–1.2 cm; bracts firm, spirally

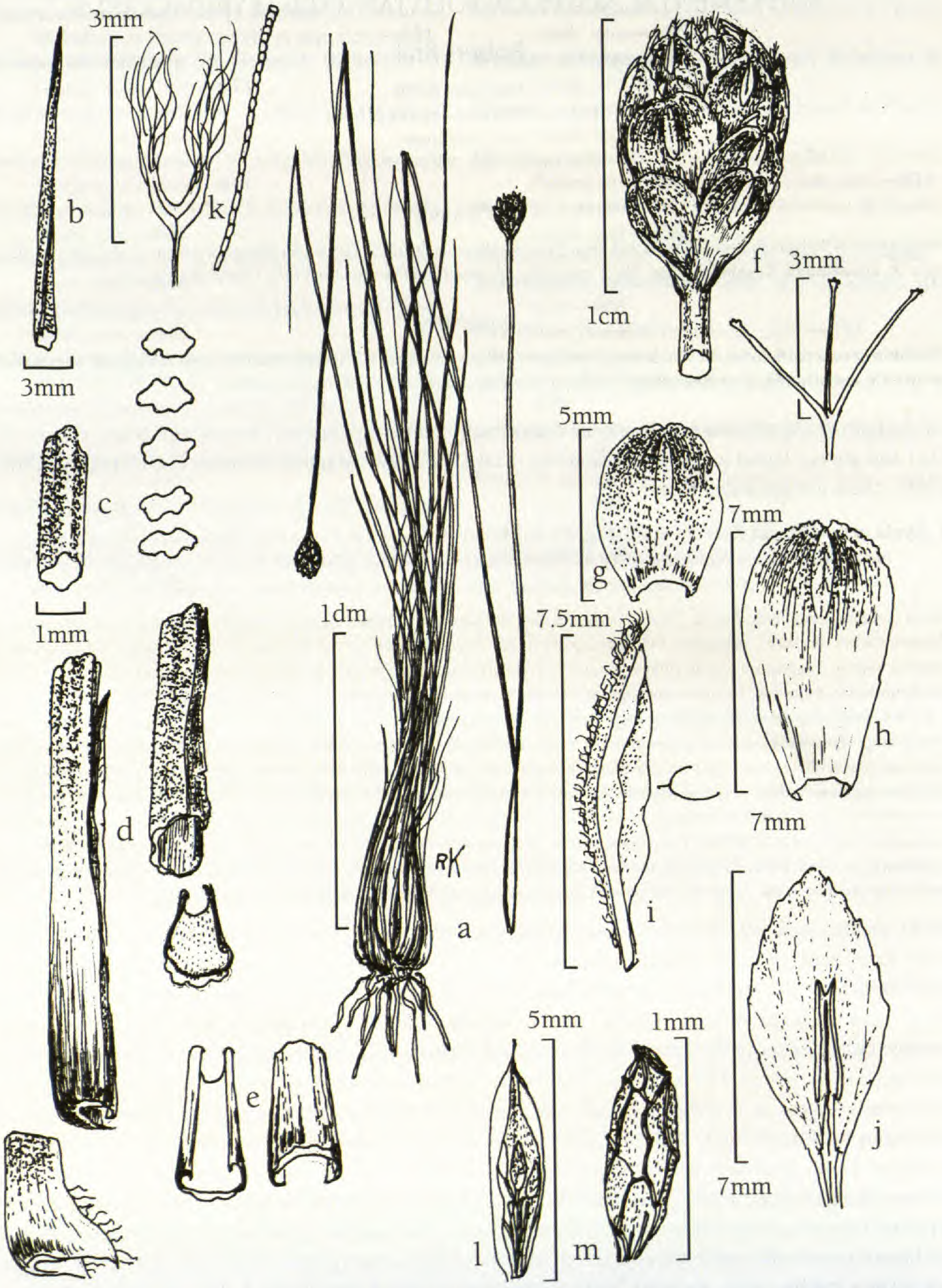

Fig. 1. *Xyris crassifunda* (from the VDB isotype). A. Habit sketch. B. Leaf apex. C. Sector of leaf midblade (right). D. Leaf base showing ligule (left, above); sector of leaf sheath and blade (right above) with idealized sector of leaf base. E. Adaxial (left) and abaxial idealized views of leaf base. F. Spike. G. Lower sterile bract. H. Lower fertile bract. I. Lateral sepal. J. Petal blade & stamen. K. Staminode (left); idealized enlargement of beard hair (right). L. Capsule, one valve removed. M. Seed.

imbricate, backs convex, ecarinate, dark red-brown with distinct, paler, narrowly elliptic dorsal area ca. 2 mm long; sterile bracts few, ovate to broadly obovate, transitional to fertile, the lower two ca. 5 mm, ovate, these obovate to oblong, 5.5–7.5 mm, the distal narrowest, all apically rounded, borders narrow, scarious, entire, becoming shallowly erose. Lateral sepals free, inequilateral, narrowly elliptic to oblanceolate, the firm keel proximally ciliolate or entire, medially increasingly crisped ciliate, apically crisped-fimbriate. Petal blades elliptic-obovate, ca.7 mm long, irregularly low-toothed apically, broadly acute, yellow. Anthers lance-linear, ca. 3 mm, apically shallowly emarginate, base sagittate, on filaments ca. 2 mm; staminodia bibrachiate, 3 mm, including dense brushes of moniliform beard hairs. Capsule narrowly oblong-ellipsoid, ca. 5 mm, placentation basal. Seeds irregularly ellipsoid, ca. 1 mm, dull red-brown with darker coarse, anastomosing, irregular ribs.

Distribution.—Known only from a meseta slope, on a sandy clay substrate by gallery forest, eastern Bolivia. Represented solely by the type collection.

Material of this xyrid shows traits both of *Xyris rigida* Kunth, Enum. Pl. 4:15, 1843, and *X. vacillans* Malme, Bih. Kongl. Svenska Vetensk.-Akad. Handl. 24, Afd. 3, No. 3: 10, plate 1, fig. 7, 1898, both of the planaltan Campos of southern Brazil, thus part of that complex of tall, slender, rush-like perennials whose leaves have distinct auricles and whose spike bracts produce distinct dorsal areas. Unfortunately it shares some of the distinguishing characters of both, but the characters are combined differently. Since this is the only example gotten thus far, it may be that intermediates will turn up as eastern Bolivia is further explored, but until such happens it seems best to introduce this as a species.

Etymology.—The name "crassifunda" refers to the thickened caudex-like base.

2. Xyris submetallica Kral, sp. nov. (**Fig. 2**). Type: BOLIVIA. Santa Cruz. Velasco Prov.: Parque Noel Kempff M. Pampa Toledo, 5–10 km al NE del campamento Los Fierros, sobre el camino a Tarbo, pampa humeda con isles arboreas termiteras, ca. 200 m, 14° 35'S, 60° 53'0"W, 1 Jul 1993, *M. Saldias, Arroyo, Mostacedo, Guillen, Gutierrez, Zapata y Pena s.n.* (holotype: USZ; isotypes: K, MO, VDB).

Planta perennis, caespitosa, 5–7 dm alta, basibus firmis, per bases persistentes veternas foliorum obtectis. Caules incrassati compactis. Folia principalia rigida, disticha, anguste flabellate expansa, 4–5 dm longa, vaginis scaporum longiora; vaginae integrae, laminis 2–3-plo breviora, a basin atrocastaneae, nitidae, dilatae, tum in laminas gradatim decrescentes, eligulatae; laminae compressae, tortae, 2–4(–4.5) mm latae, minute punctatae; apices anguste incurvato-acuti; margines leviter incrassates, scabridis. Vaginae scaporum prope basem nitidae, rufobrunneolae, teretes, multicostatae, apicem versus apertae, laminis brevibus. Scapi apicem in sectio transversalis ovati, ca. 1–1.2 mm lati, leviter compressi, multistriati, punctati, unicostati, costis scabridis aut papillosis. Spicae multiflorae, obovoideae, ca. 1.2 cm longae, obtusae, attenuatae. Bracteae erectae, laxe spiraliter imbricatae, vadose convexae, lamprobrunneolae, sine area dorsalis, integrae tum minute laceratae; bracteae steriles plures, in fertiles gradatim transientes, infimis ovatis, usque ad 6 mm; bracteae fertiles 6–7 mm anguste ovatae in oblongae gradatim transientes. Sepala lateralia libera, leviter inequilateralia, oblongo-lanceolata, ca. 7 mm longa, ale carinali a basin ad apicem ciliatis vel ciliolatis. Laminae petalorum late oblongae, flavae, ca. 5 mm longae. Antherae lanceolate-oblongae, sagittatae et emarginatae, 2–2.5 mm longae. Capsula oblongo-lanceoloidea, ca. 5 mm longa; placenta basalis. Semina asymmetrice ellipsoidea, 0.7–0.8 mm longa, atroferrugineofusca, multicostata.

Stout-based, caespitose perennial 5–7(–8 est.) dm, the stems contracted, hard. Leaves erect or in narrow fans, the outermost mostly scale-like, bladeless. Principal leaves 4–5 cm, sheaths ca. ½–⅓ as long as blades, entire, abruptly dilated, convex, multicostate at base, castaneous, distally keeled, gradually narrowed, eligulate, to blade; blades linear, flattened, 2–3 mm wide, shallowly several-nerved, surface smooth with lines of elliptic punctae, margins narrowly incrassate, densely scaberulous, narrowed to a narrowly acute, somewhat thickened, apex. Scape sheathes tubular, lustrous red-brown, twisted, short-bladed, shorter than leaves. Scapes erect to ascending, twisted, proximally ca. 1.5 mm, distally ca. 1 mm thick, rounded to oval in cross-section with low, irregular ribs, smooth save for lines of narrowly elliptic punctae and one strong, scaberulous costa. Spikes obovoid, ca. 1.2 cm long, of many, spirally imbricate, convex, brownish or reddish-brown, lustrous bracts without evident dorsal areas, base attenuate, of many sterile bracts, the lower ones smallest, broadly ovate, ca. 2 mm, grading upward to larger, progressively longer, more oblong fertile ones; fertile bracts prevalently oblong-ovate to oblong, 5.5–7 mm, those of midspike and above narrowest in outline, apically rounded-emarginate, erose or entire, and with a prominent, though narrow, raised midvein cresting a shallow apical angle. Lateral sepals free, inequilateral, oblong-lanceolate to oblong-oblanceolate,

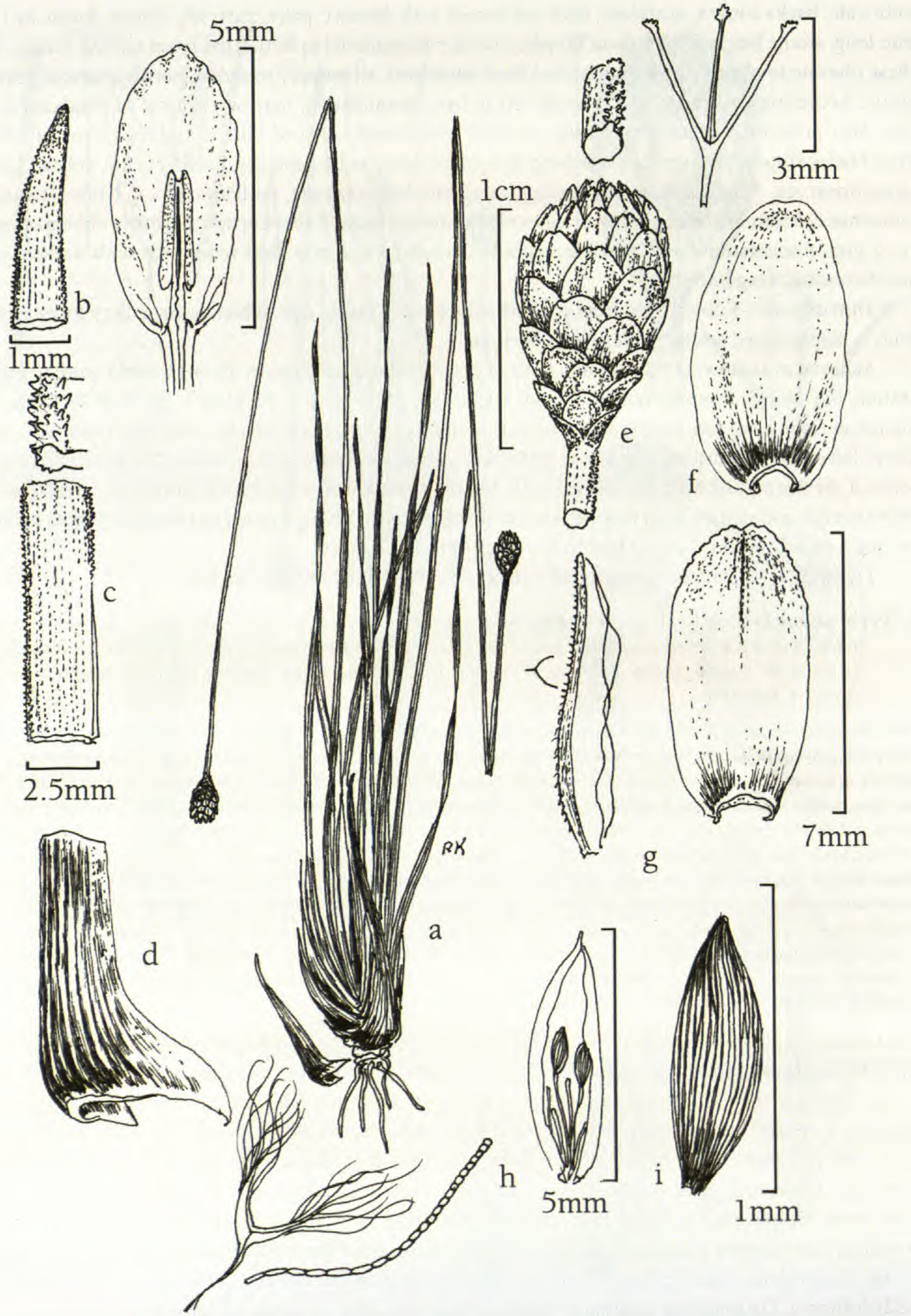

Fig. 2. *Xyris submetallica* (from the VDB isotype). A. Habit sketch. B. Leaf apex. C. Sector of leaf midblade and junction with sheath (below); small sector of blade margin. D. Leaf base. E. Spike & scape sector. F. Lower fertile bract (above); upper fertile bract (below). G. Lateral sepal. H. Staminode and idealized sector of beard hair (left); capsule, showing placentation. I. Seed. J. Petal blade & stamen. K. Stylar apex.

ca. 7 mm long, the narrow, firm, shallowly sigmoid-curved keel mostly antrorsely or retrorsely pilosulous-ciliate medially, antrorsely ciliolate distally. Petal blades (est.) oblong-elliptic, ca. 5 mm, bluntly acute, yellow. Anthers lance-oblong, 2–2.5 mm, emarginate and sagittate, on stout filaments ca. 2 mm. Capsules lanceoloid, ca. 5 mm, light brown; placentation basal. Seeds asymmetrically ellipsoid, 0.8–0.9 mm, dark red-brown, not farinose, longitudinally finely multiribbed.

Distribution.—Known thus far only from the type locality, one of humid grasslands around forested islands and amongst termite mounds.

In character of habit, leaf, and scape this example fits *Xyris metallica* Klotsch ex Seub. However, the spikes are longer, attenuate (thus narrower-based), and with several more sterile bracts of distinctly different character. Many of the mid and upper bracts of a spike have distinct, if shallow, keels apically, with strong midnerves (apically often darker-pigmented) marking the crests of that shallow angle. The lateral sepals and seeds are longer.

Etymology.—The name "submetallica" is applied here against the possibility that connecting morphologies will prove a relationship.

ACKNOWLEDGMENTS

The kindness of curators as well as that shown by the original collectors is very gratefully acknowledged. Richard Carter (VSC) kindly assisted with technical aspects of preparing the manuscript. I kindly thank two anonymous reviewers for their helpful comments.

REFERENCES

Kral, R. 1988. The genus *Xyris* (Xyridaceae) in Venezuela and contiguous northern South America. Ann. Missouri Bot. Gard. 75:522–722.

Kral, R. 1994. Xyridaceae. In: Flora of the Guianas, Ser. A: Phanerogams, fasc. 15. Koeltz Scientific Books. Königstein, Germany.

Maguire, B. and L.B. Smith. 1964. Xyridaceae. In: B. Maguire, J.J. Wurdack, and collaborators. The botany of the Guayana Highland—Part V. Mem. New York Bot. Gard. 10(5):7–37; figs. 1–22.

Smith, L.B. and R.J. Downs. 1968. Xyridaceae. In: F.C. Hoehne, Fl. Brasilica 9(2):1–215.

BOOK REVIEW

Wolfgang Stuppy and Rob Kesseler. 2008. **Fruit: Edible, Inedible, Incredible.** (ISBN 978-1-554-07405-1, hbk.). Firefly Books Inc., P.O. Box 1338, Ellicott Station, Buffalo, New York 14205, U.S.A. (**Orders:** service@fireflybooks.com, 1-800-387-5085, 1-800-565-6034 fax). $60.00, 264 pp., selection of color images, preface, and appendices, 11 ¼" × 12 ½".

Fruit: Edible, Inedible, Incredible consists of numerous color images that vary from those taken with light and scanning electron microscopy to flash photography that have been digitally enhanced to artist's impressions. These images are beautiful to say the least and will draw any reader's attention to the exquisite detail of the particular specimen. Stuppy and Kesseler also provide detailed descriptions of the plant, fruit, or insect that is imaged. Throughout the book, the authors are determined to specifically define a fruit, explain how it is formed, as well as give more information on the wide variety of forms that are found in nature.

Stuppy, a seed morphologist, explains the true story of why fruits are important: simply for the seeds that are found within. Fruits and seeds have forged a partnership to help continue plant survival. One can see this through the diverse methods that have been developed to disperse seeds via wind, water, animal, insect, etc. All of this information is easily seen through the images that Kesseler provided.

This book would make a wonderful coffee table collection for anyone. Young and old will be enthralled by the simple stories that these images share and the information that has been provided. Overall, this book was very easy to understand, and I would easily suggest this for a person interested in learning more about the wide variety of fruits or simply interested in nature photography.—*Keri McNew Barfield, MS Biology, Research Programs Manager, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

TWO NEW BOLIVIAN SPECIES OF *AULONEMIA* (POACEAE: BAMBUSOIDEAE: BAMBUSEAE)

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ABSTRACT

Two new Bolivian bamboo species, **Aulonemia bromoides** and **A. scripta** (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae), are described and illustrated. Both species are known from just one collection each in montane forests (elevations between 1800–2000 m) in Parque Nacional Madidi in the Department of La Paz. For both species, the abaxial leaf blade surface was examined using a scanning electron microscope (SEM). *Aulonemia bromoides* is characterized by its large, efimbriate leaf blades with elongate 20–25 mm long foliaceous inner ligules, and robust spikelets with prominently nerved florets. *Aulonemia scripta* is distinguishable from its congeners by the following combination of characters: the culms are both viscid and hollow; the leaves are also viscid; and the spikelets are awned. The only other members of the Bambusoideae known to have viscid foliage are two congeners from Costa Rica, *Aulonemia patriae* and *A. viscosa*; they have pulpy, succulent, easily crushable solid culms and awnless spikelets. Since only a single collection of each species is known to exist, we recommend to the International Union for the Conservation of Nature (IUCN) that they both be assessed as Critically Endangered.

RESUMEN

Dos especies nuevas de bambúes bolivianos, **Aulonemia bromoides** y **A. scripta** (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae), son descritas e ilustradas. Ambas especies son conocidas solamente a partir de un espécimen colectado en los bosques montanos (a elevaciones entre 1800–2000 m) en el Parque Nacional Madidi, Departamento de La Paz. En ambas especies, se examinó la lámina abaxial con microscopio electrónico de barrido. *Aulonemia bromoides* se caracteriza por sus hojas grandes sin fimbrias, con lígulas internas foliáceas y elongadas (20–25 mm), y por sus espiguillas robustas con nervios prominentes. *Aulonemia scripta* se diferencia de sus congéneres por la combinación de los siguientes caracteres: Culmos viscosos y huecos, hojas también viscosas, y espiguillas aristadas. Las únicas especies del Bambusoideae que poseen follaje viscoso son dos congéneres costarricenses, *Aulonemia patriae* y *A. viscosa*; estos tienen culmos sólidos, pulposos, suculentos y débiles, y espiguillas sin aristas. Debido a que existe únicamente una colección de cada especie, recomendamos a la International Union for the Conservation of Nature (IUCN) que éstas sean denominados "Críticamente Amenazadas."

INTRODUCTION

Aulonemia Goudot (Poaceae: Bambusoideae: Bambuseae: Arthostylidiinae) is a genus of about 34 species of woody bamboos (McClure 1973; Calderón and Soderstrom 1980; Clayton and Renvoize 1986; Judziewicz et al. 1999; Judziewicz et al. 2000). Of the 34 species that we currently recognize within the genus, 20 have been described since 1990 (Clark 2004; Clark et. al. 2007; Clark and Londoño 1990; Clark et al. 1997; Judziewicz 2005; Judziewicz et al. 1991; Judziewicz and Riina 2005; Judziewicz and Tyrrell 2007; Renvoize 1998). The Andean countries of Venezuela, Colombia, Peru, and Bolivia appear to have many new species of *Aulonemia* awaiting description (Judziewicz, pers. obs.).

Recent collections from the Parque Nacional Madidi (http://www.mobot.org/MOBOT/Research/madidi/) on the northern slope of the Andes in the Department of La Paz, in western Bolivia have revealed a number of distinctive new species of *Aulonemia*, two of which are described below. Specimens were examined from

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several herbaria (F, ISC, K, MO, P, US, UWSP and WIS), but only MO had representatives of the new taxa. Plant parts were measured using a mm ruler, and the abaxial leaf blade epidermis of both species was examined using dried material in a Hitachi S3400 scanning electron microscope. Neither taxon is included in the most recent treatment of Bolivian grasses (Renvoize 1998: 38–41). The following key differentiates the (six) described species now known to occur in Bolivia:

1. Culms with alternating long and very short internodes; culm leaves well-developed, with fimbriate auricles at least 10 mm long ______ **A. herzogiana** (Henrard) McClure
1. Culms with internodes all the same length; culm leaves absent or poorly-developed, if present then lacking fimbriate auricles
   2. Plants with culms and leaves viscid (sticky) ______ **A. scripta** Judz., Shea & Wayda
   2. Plants not at all viscid (sticky).
      3. Foliage leaves with prominent papery, foliose inner ligules 20–25 mm long; leaf blades 5.3–6.7 cm wide; lemmas with prominent green veins ______ **A. bromoides** Judz., Wayda & Shea
      3. Foliage leaves with membranous small inner ligules less than 4 mm long; leaf blades cm wide; lemmas not with prominent green veins.
         4. Foliage leaves with prominent sheath auricles ca. 3 mm long ______ **A. boliviana** Renvoize
         4. Foliage leaves lacking sheath auricles.
            5. Branches of inflorescence glabrous or scabrous, not pubescent; leaf blades 2.0–3.8 cm wide ______ **A. longipedicellata** Renvoize
            5. Branches of inflorescence covered with spreading hairs 2–4 mm long; leaf blades 1–2 cm wide ______ **A. tremula** Renvoize

Aulonemia bromoides Judz. & Shea, sp. nov. (**Figs. 1, 2, 3D–F**). TYPE: BOLIVIA. LA PAZ: Prov. Franz Tamayo: Senda Apolo-San José de Uchupiamonas, a media hora de 3 de Mayo, hacia Turnia, 14°33.654'S [=39.2"], 68°20.076'W [=04.6"], 1824 m [1740 m on Google Earth], hierba graminoide 2 m, tallo hueco, espigas verde plomizo, 22 Apr 2003, *Leslie Cayola Pérez, Tatiana Miranda & Freddy Canqui 289* (HOLOTYPE: LPB!; ISOTYPES: MO 4793775! 4793776!).

Culmi usque ad 12 mm diam., 2 m alti. Vagina foliorum quasi glabra, nonauriculata, efimbriata; ligula 20–25 mm, chartacea; lamina foliorum 18–25 cm longa, 5.3–6.7 cm reflexa. Inflorescentia paniculata, 25–35 cm longa. Spiculae 27–37 mm longae, glabra, straminea, cum nervatas virides prominentes, 4–5 flosculos fertiles continentes; glumae 2, lanceolatae, acutae; gluma I 4.0–5.2 mm longa, gluma II 5–6 mm longa; lemmata fertilia 12.5–14.5 mm longa, lanceolata, acuta.

Apparently cespitose from sympodial rhizomes; culms to 2 m tall, up to 1.2 cm in diameter, hollow, the lumen occupying 40–70% of the diameter of the culm; culms apparently dimorphic, some with well-developed foliage leaves and terminal inflorescences, others with poorly-developed culm leaves, no foliage leaves, and terminating in inflorescences, the culms thus apparently dimorphic. Culm leaves with sheaths 3–18 cm long, 0.8–1.2 cm wide (folded width), glabrous, with a minute inner ligule and no outer ligule or auricles, efimbriate, bladeless or with tiny erect blades ca. 2.5 mm long and 1.5 mm wide. Culms with lower internodes glabrous, slightly purplish and verrucose, the upper internodes slightly striate, glabrous or with scattered glassy appressed hairs 0.7–1.5 mm long. Branching pattern not seen. Foliage leaves in complements of at least 3, efimbriate; sheaths slightly striate, glabrous or with scattered glassy appressed hairs 0.7–1.5 mm long, stramineous with tiny gray or purple maculae, lacking an auricle at the summit; outer ligules abaxially 1 mm long, laterally 1.5–2 mm long; inner ligules 20–25 mm long, foliaceous, linear-lanceolate, pale stramineous (at least when mature); pseudopetioles 4–6 mm long; blades 18–25 cm long, 5.3–6.7 cm wide, lanceolate-ovate, obtuse to slightly cuneate at the base, acuminate at the apex, reflexed, glabrous, the margins cartilaginous and somewhat antrorsely hispid. Inflorescence an ovoid panicle 25–35 cm tall and 17–22 cm wide with the base included in the uppermost leaf sheath; rachis and primary branches smooth, glabrous, and slightly maculate, the primary branches ascending at a 45° angle, the secondary branches and pedicels capillary and antrorsely scabrous, the pedicels up to 6 cm long. Spikelets 40–43 mm long, 3.0–4.1 mm wide, robust, stramineous with prominent grayish-green nerves, glabrous, the bracts all acute and awnless with pubescent margins; lower glume 2.7–4.4 mm long, 0.8–1.3 mm wide (folded), lanceolate to lance-ovate, 3–5-nerved, some of the lateral nerves not extending to the apex; upper glume 4.8–6.7 mm long, 1.0–1.6 mm wide (folded), lanceolate, 5–7-nerved, some of the lateral nerves not extending to the apex; lowermost floret sterile, lacking a palea, 6.1–10.1 mm long, 1.1–2.0 mm wide (folded), lanceolate, 7–9-nerved; second

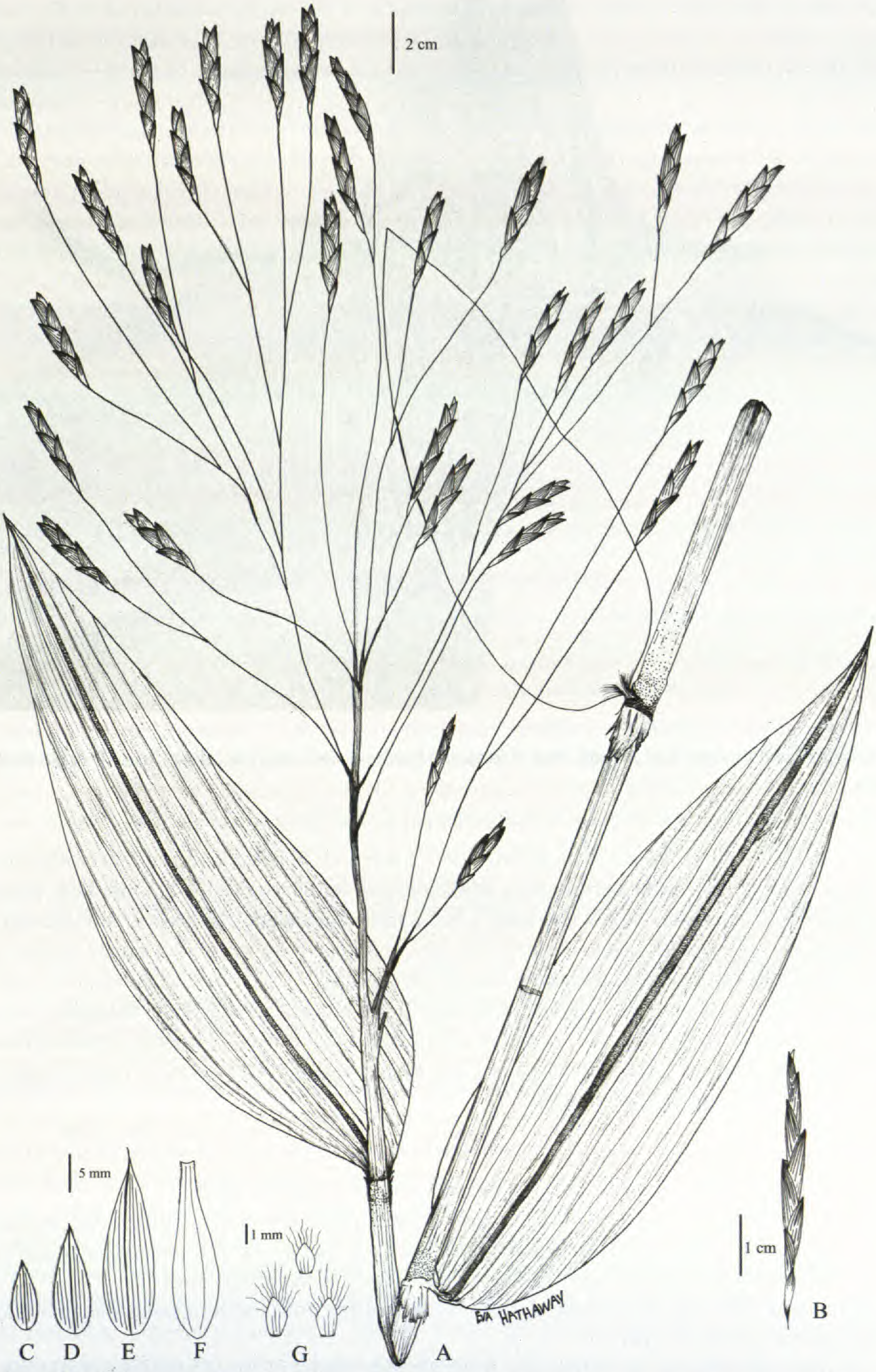

FIG. 1. *Aulonemia bromoides* (*Cayola et al. 289*, MO). **A.** General habit of flowering culm. **B.** Spikelet, lateral view. **C.** Lower glume. **D.** Upper glume. **E.** Lemma. **F.** Palea. **G.** Lodicules. Illustration by Eva Hathaway.

Fig. 2. *Aulonemia bromoides* (*Cayola et al. 289*, MO). Detail of foliage leaf showing elongate papery inner ligule (here split longitudinally during pressing).

floret also sterile, lacking a palea, 9–11 mm long, 1.9–2.5 mm wide (folded), lanceolate, 9–11-nerved; rachis internodes between uppermost sterile lemma and lowermost fertile lemma 1.9–2.2 mm long, pubescent; fertile florets 4–5; lemmas 11.7–14.9 mm long, 2.5–2.8 mm wide (folded), lanceolate, 9–11-nerved, some of the lateral nerves not extending to the apex, the apex and uppermost margins minutely ciliolate; paleas 8.4–12.5 mm long (as long as the lemmas and not protruding), 1.5–2.9 mm wide, elliptical, greenish-stramineous, bicarinate, the keels ciliolate; lodicules 3, prominent, 1.5 mm long, lanceolate-rhomboid, acute, transparent, with 2–3 fine short nerves near base, the margins densely fringed with erect clear cilia 1.2–1.7 mm long; stamens 3, the anthers 3.6–6.2 mm long, 0.4–0.8 mm wide, linear, rusty orange-brown; pistil with 2 hispid stigmas. Fruit not seen.

Leaf anatomy of abaxial leaf blade epidermis (Fig. 3D–F; terminology follows Ellis 1979).

Costal zones.—Spaced 200 µm apart.

Papillae.—In general common, globose to slightly oblique; simple; variable.

Stomates.—Common; shape triangular to dome-shaped, partly obscured by overarching papillae; each stomate overarched by 4 irregularly compound papillae, each papillae ca. 5–8 µm long; stomatal rows 2, distinct, flanking each costal zone and slightly extending into the intercostal zone.

Interstomatal cells.—ca. 30 µm long, narrow, width variable; ends indeterminable due to overarching papillae; papillae sparse, 3–5 per cell.

Long cells.—Rectangular, 30–80 µm long, 8–10 µm wide, outline of cells sinuous; papillae sparse, 3–12 per cell, 3–5 µm long, apparently minutely concave at summit.

Prickles.—None seen.

Short cells.—Abundant, ca. 25 µm tall, 17–25 µm wide, abundant, slightly raised, in ca. 5 rows (60–70/mm) in intercostal zones, ca. 3 rows (30–45/mm) in costal zones.

Microhairs.—Few; two-celled; basal cell 15–33 µm long, 7–8 µm wide; apical cell (only one seen) 25 µm.

Macrohairs.—None seen.

Aulonemia bromoides, known only from the type locality in the Parque Nacional Madidi, La Paz, Bolivia, is distinctive in its combination of large efimbriate leaves with elongate papery inner ligules (Fig. 2), and robust spikelets with prominently nerved florets somewhat resembling those of a species of the grass genus *Bromus* L. (hence the specific epithet). It has been suggested that these elongate inner ligules may represent, at least in part, fused fimbriae such as are prominently manifested in the Brazilian species *Aulonemia fimbriatifolia* L.G. Clark (pers. comm.). The only other described species of *Aulonemia* with elongate, papery inner ligules is the Peruvian endemic *A. parviflora* (J. Presl) McClure. It differs from *A. bromoides* in its generally narrower ((3–) 3.7–5.8 cm wide), linear-lanceolate to lanceolate, abaxially tessellate leaf blades and smaller (7.5–9.5 mm long), more weakly-nerved, mucronate lemmas (Tovar 1993; also examination of *McClure 21453*, US).

Aulonemia bromoides is assessed as Critically Endangered because its EOO (extent of occupancy) is (as far as is known) less than 100 km^2, and it is only known to occur at a single location; thus, criterion CR B1a of the IUCN (2001) applies.

Aulonemia scripta Judz. & Wayda, sp. nov. (**Figs. 3A-C,4, 5, 6**). Type: BOLIVIA. La Paz: Prov. Franz Tamayo: Senda Apolo-San José de Uchupiamonas, quebrada antes de cruzar Arroyo Huacataya, 14°31.478'S [=28.7"], 68°17.914'W [=54.8"], 1960 m [1980 m on Google Earth], hierba graminoide 50 cm, espigas verde amarillentes, 10 Jul 2002, *Carla Maldonado G., Tatiana Miranda, Freddy Canqui & R. Alvarez 3100* (holotype: LPB!; isotypes: MO 4793771! 4793772!).

Culmi 7 mm diam., 0.5 m alti. Vagina foliorum glabra, viscida, auriculata (3 × 1 mm), tantum ad apicem fimbriata; fimbriae 4–8 mm longae, sparsa, delicata; lamina foliorum 16–18 cm longa, 2.0–2.7 cm lata, reflexa, viscida. Inflorescentia paniculata, 20–23 cm longa. Spiculae 22–26 mm longae, puberulentes, 3–5 flosculos fertiles continentes; glumae 2, lanceolatae, acutae; gluma I 2.0–2.5 mm longa, gluma II 5.5–7 mm longa; lemmata fertilia 10–12 mm longa, lanceolata, aristata, arista 4–5.5(–7) mm longa.

Habit uncertain, perhaps cespitose; culms reportedly only 0.5 m tall, in available material 7 mm in diameter near base, hollow, the lumen about 30% of the diameter of the culm; internodes glabrous, brownish, shiny and apparently viscid in life. Culm leaves with lower sheaths stramineous and maculate with scattered tiny black dots, striate, shiny (appearing varnished), apparently viscid in life as evidenced by newsprint lettering impressed on culm (Fig. 4), bladeless or with tiny reflexed blades up to 2 cm long, gradually transitioning to typical foliage leaves. Promontory absent; branch one per node. Foliage leaves in complements of up to at least 12; sheaths striate, apparently viscid, glabrous or finely puberulent near the apex, lacking marginal fimbriae; sheath auricles rare, only one delicate arcuate auricle ca. 3 × 1 mm seen on just one leaf; terminal fimbriae sparse, 0–2 per leaf, each 4–8 mm long, delicate, curling; outer ligules 1–2 mm long; inner ligules 1.5–2.5 mm long, membranous; pseudopetioles 5–6 mm long; blades 16–18 cm long, 2–2.7 cm wide, somewhat coriaceous, strongly reflexed, narrowly lanceolate, obtuse at base, long-acuminate at apex, glabrous and apparently viscid above, finely and densely antrorsely scaberulous and apparently at least sparingly viscid beneath, the margins cartilaginous, smooth below and somewhat scabrous above. Peduncle 6–8 cm long, smooth and glabrous. Inflorescence an ovoid panicle 20–23 cm tall and 12–20 cm wide, with few primary branches laxly ascending at a 45° angle, the rachis and primary branches smooth and glabrous, the secondary branches and pedicels capillary and antrorsely scaberulous. Spikelets 18.3–23.1 mm long, 2.9–5.5 mm wide (folded), stramineous to yellowish, 6–8 flowered, perhaps viscid; glumes lanceolate, pubescent, acute, the lower glume 2.1–3.0 mm long, 0.8–1.2 mm wide (folded), 3–7-nerved, awnless, the upper glume 6.0–7.8 mm long, 1.0–1.3 mm wide (folded), 9–11-nerved, awns 0.4–0.5 mm long; florets largest below, the uppermost floret sterile and reduced in size; lemmas with bodies 9.1–11.6 mm long, 1.5–2.1 mm wide (folded), lanceolate, puberulent throughout, finely 9–15-nerved, the apex acute but terminated by an abrupt, erect, antrorsely scabrous awn 1.0–4.7 mm long; paleas 8.0–11.0 mm long (as long as lemmas, flush with or slightly protruding from their margins and apex), 1.1–1.9 mm wide, elliptical, stramineous, bicarinate, the keels ciliolate; lodicules 3, 1–1.3 mm long, flabellate, obtuse, transparent, with 2–3 fine short nerves

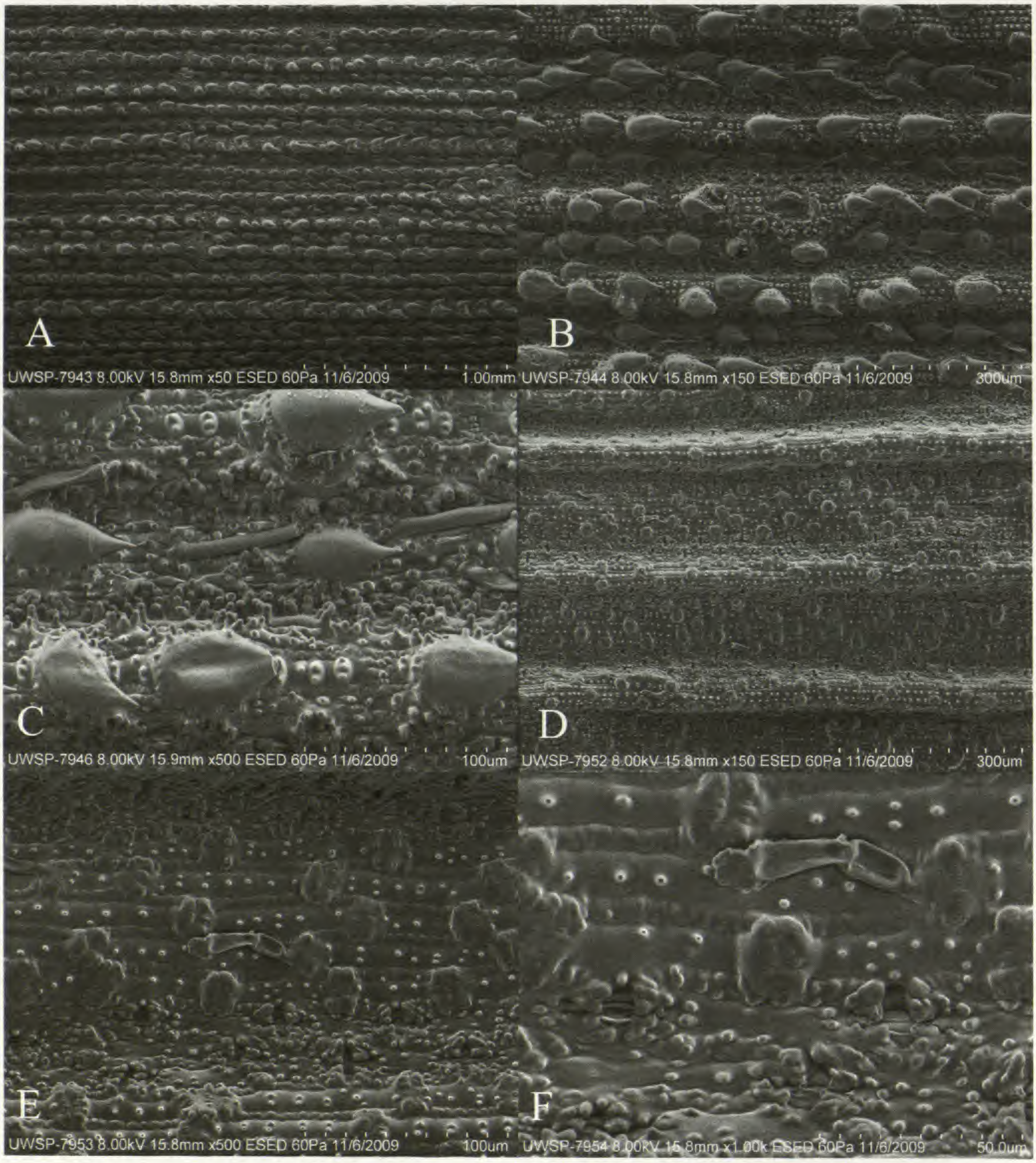

Fig. 3. Scanning electron micrographs of abaxial (lower) leaf blade epidermis of *Aulonemia scripta* (A–C, at increasing magnification, showing abundant prickles and papillae; *Maldonado et al. 3100*, MO) and *A. bromoides* (D–F, at increasing magnification, showing prominent intercostal short cells, bicellular microhairs, lack of prickles, and relatively sparse papillae; *Cayola et al. 289*, MO).

near base, the margins densely fringed with erect clear cilia ca. 0.5 mm long; stamens 3, the filaments apparently dilated, the anthers 4.5 mm long, 0.8 mm wide, linear, stramineous to brown. Fruit 4.3–5.9 mm long, 0.7–1.0 mm wide, narrowly oblong, rusty brown; embryo 2.9 mm long, 0.8 mm wide; hilum 4.1–5.4 mm long; all fruits observed were immature.

Leaf anatomy of abaxial leaf blade surface (Fig. 3A-C; terminology follows Ellis 1979).

Costal zones.—Spaced ca. 150 µm apart.

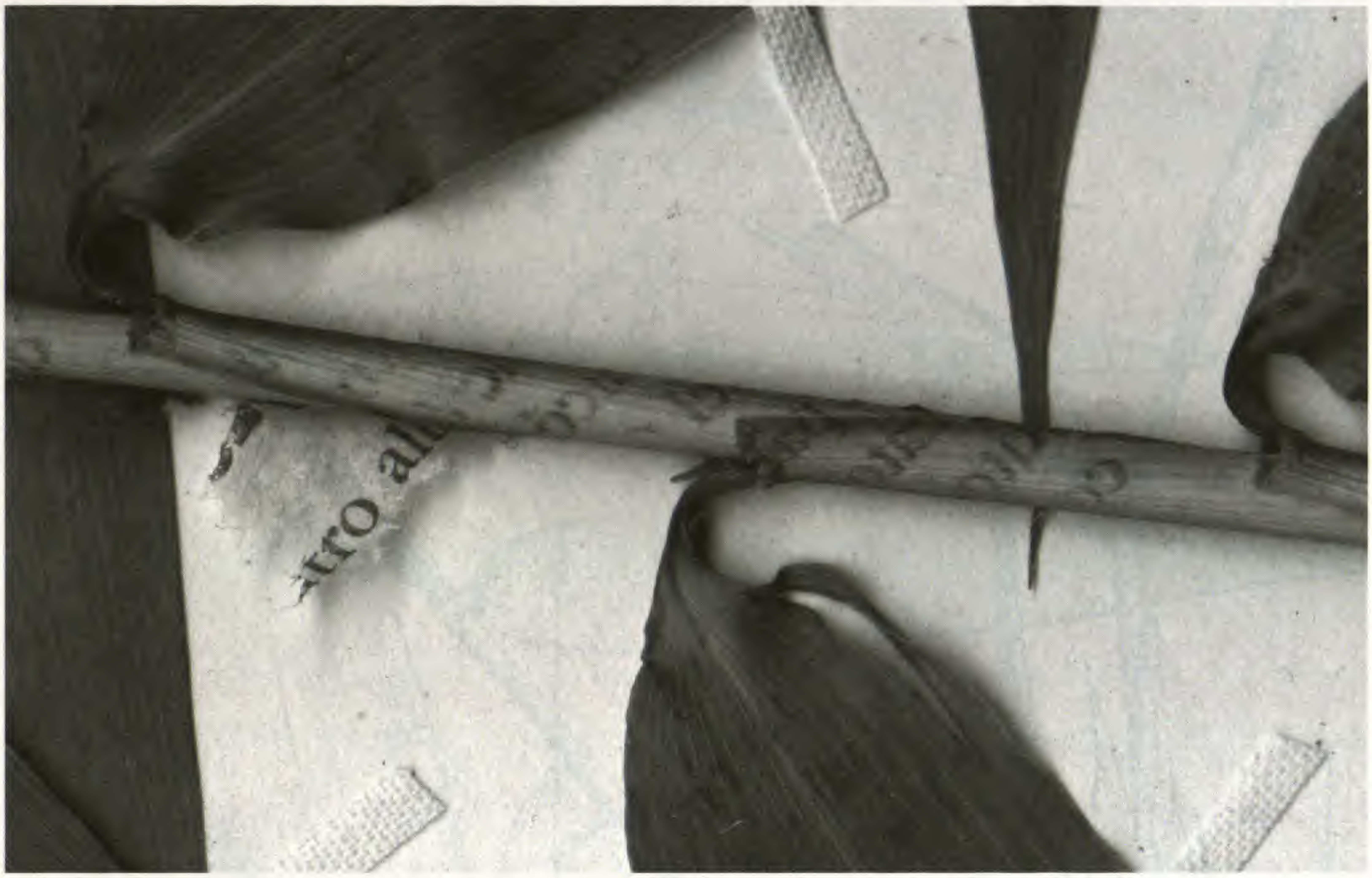

Fig. 4. *Aulonemia scripta* (*Maldonado et al. 3100*, MO). Detail of specimen showing newsprint adhering to and imprinted upon culm and leaves.

Papillae.—In general very abundant; up to 12 µm long and 6 µm wide, variable, occasionally slightly branched at the apex.

Stomates.—Common; shape unknown, possibly triangular, nearly obscured by overarching papillae; each stomate overarched by 9–15 papillae, each papillae 4–12 µm long; stomates in 2 rows flanking each costal zone and slightly extending into the intercostal zone.

Interstomatal cells.—Shape apparently rectangular, often nearly obscured by papillae; papillae absent or solitary, globose to slightly oblique.

Long cells.—Rectangular, 40–60 µm long, 4–6 times as long as wide; outline of cells sinuous; papillae simple, in one or two rows, globose.

Prickles.—Abundant, 10–20 prickles/mm in 1–2 rows in both costal and intercostal zones, individual prickles 40–110 µm long, base at least twice as long as the stomates, the barb shorter than the base.

Short cells.—Not evident, perhaps obscured by over-arching papillae.

Microhairs.—Common; two-celled, the basal cell 60–80 µm long, 10–12 µm wide, the apical not seen, apparently detached in SEM preparation.

Macrohairs.—None seen.

Known only from the type locality in Parque Nacional Madidi, La Paz, Bolivia, *Aulonemia scripta* is distinctive in its apparently viscid hollow culms, viscid leaves, and awned spikelets. The specific epithet of the new species alludes to the newsprint that is imprinted upon and adhering in fragments to the culm and leaves of the type collection. The culms, branches, leaf sheaths, and lower leaf blade surfaces also have a shiny "varnished" appearance suggestive of viscidity. The collectors did not note any stickiness on their label notes, but this is not surprising: In another new species of *Aulonemia* from Brazil (Pedro Viana, pers. comm. from field observations) with viscid foliage (and spikelets), the collector, the late Thomas R. Soderstrom, who took copious field notes on the bamboos he collected, does not note any viscidity, and viscidity is not apparent in his dried specimens (Judziewicz, pers. obs.). Besides *Aulonemia scripta* and the unpublished

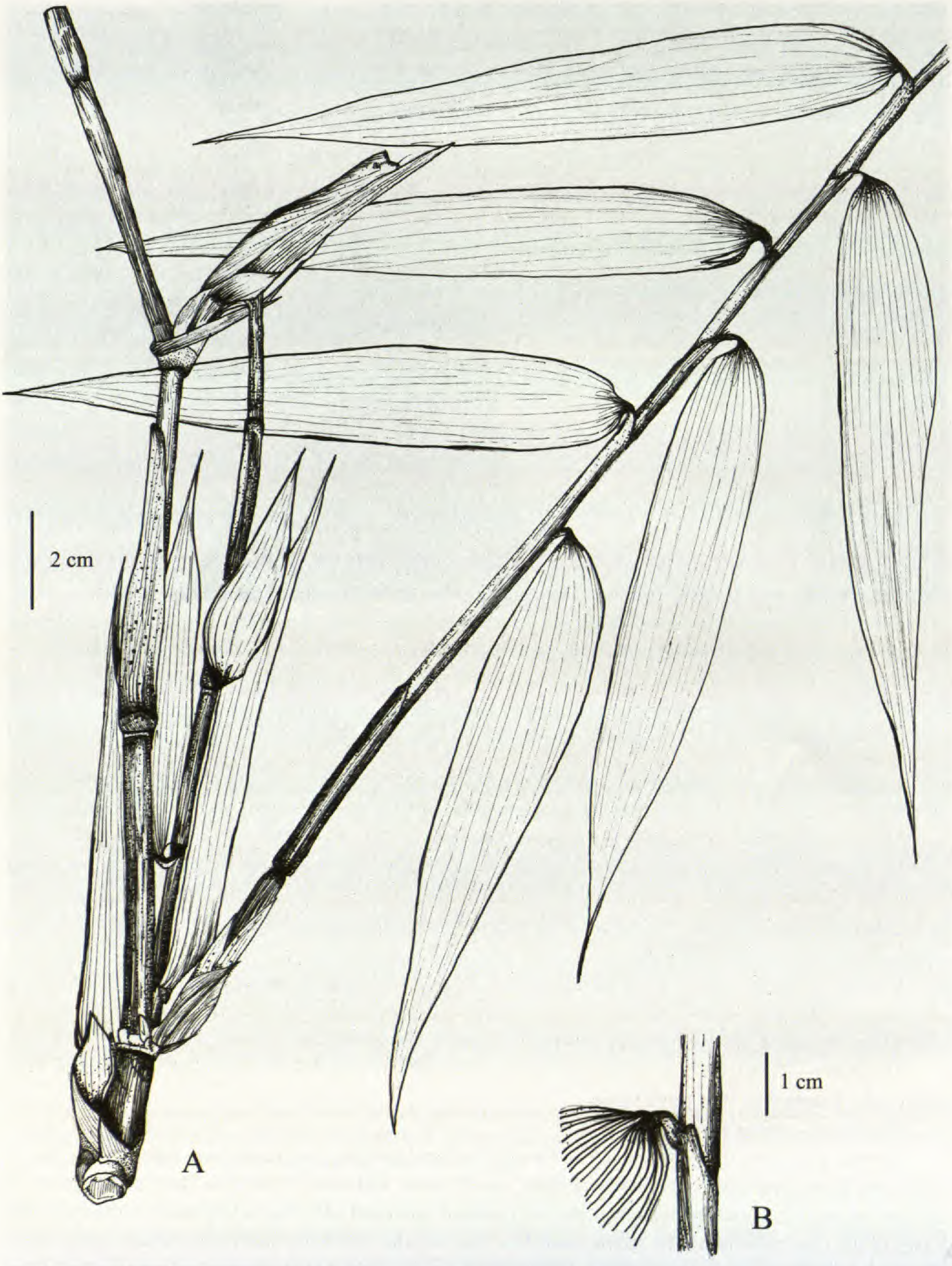

Fig. 5. ***Aulonemia scripta*** **(*Maldonado et al. 3100*, MO). A. Vegetative habit showing branching pattern. B. Summit of leaf sheath and base of blade. Illustration by Eva Hathaway.**

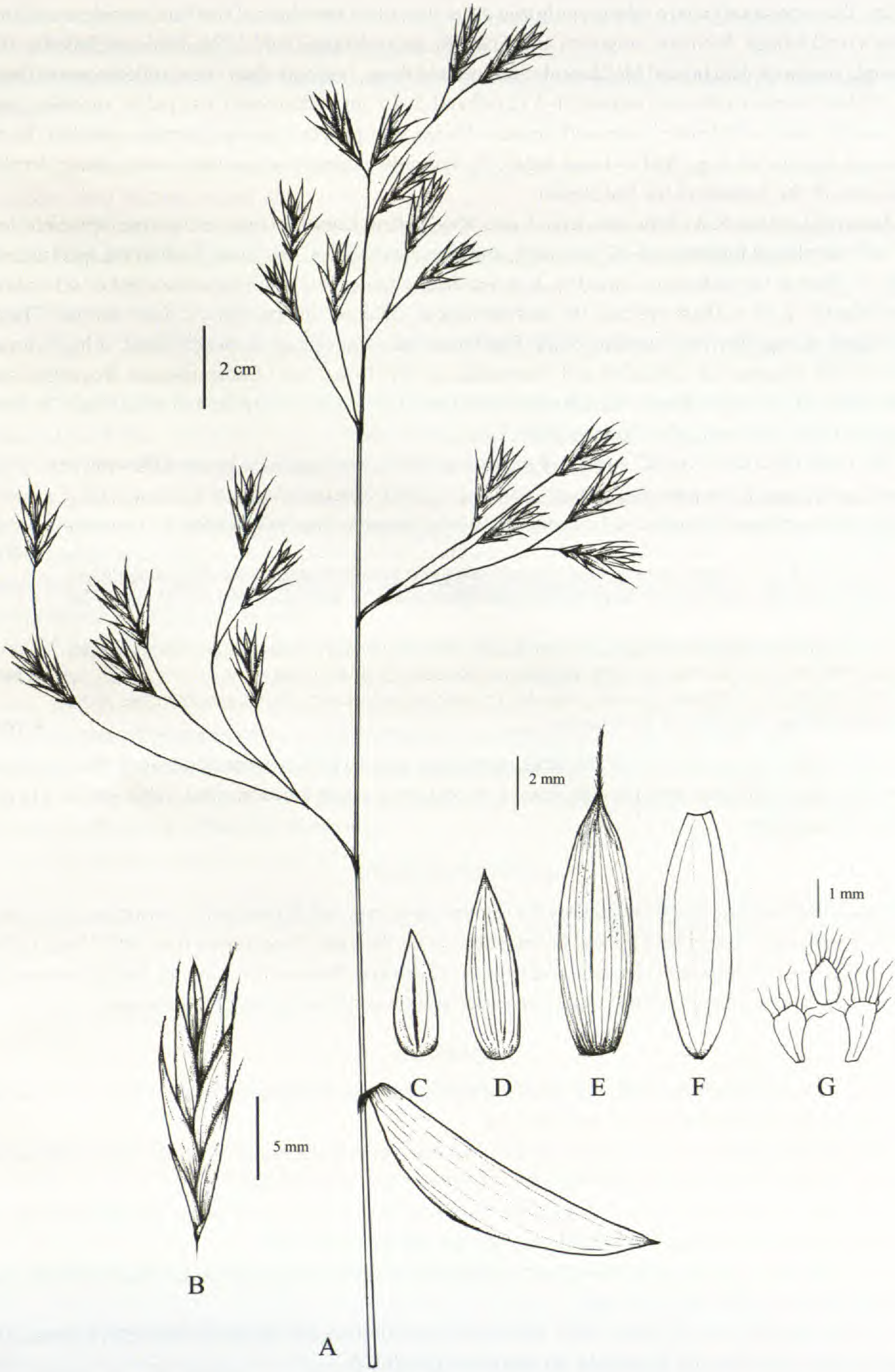

Fig. 6. *Aulonemia scripta* (*Maldonado et al. 3100*, MO). **A.** Summit of flowering culm. **B.** Spikelet, lateral view. **C.** Lower glume. **D.** Upper glume. **E.** Lemma. **F.** Palea. **G.** Lodicules. Illustration by Eva Hathaway.

new Brazilian species alluded to above, only two other described members of the Bambusoideae are known to have viscid foliage. Both are congeners and Costa Rican endemics (Pohl 1980; Pohl and Davidse 1994). *Aulonemia viscosa* (A. Hitchcock) McClure also has viscid foliage, but it also has viscid inflorescences (including spikelets), is more robust in stature (4–5 m tall and 5–15 cm in diameter), has pulpy, succulent, easily compressed culms, efimbriate leaves with broader blades, and purple-maculate awnless spikelets. In dried herbarium specimens (e.g., *Pohl & Lucas 13113*, F), the only evidence of viscidity is the shiny, varnished appearance of the summit of the leaf sheath.

Aulonemia patriae R.W. Pohl, also from Costa Rica, differs from *A. scripta* in its larger spikelets, leaves with well-developed fimbriae 15–30 mm long, and ovate leaf blades; in a dried herbarium specimen (*Pohl 12798*, F), there is no evidence of viscidity. It is not clear whether viscid foliage arose once or several times independently in all of these species; the morphological variation among them is quite diverse. The only other report of viscidity in a member of the Bambusoideae is in *Chusquea spencei* Ernst, a high elevation species of the páramos of Colombia and Venezuela, in which the culm internodes are frequently sticky (Clark 1989: 58). In other plants, viscidity has been postulated to be an attribute of what might be termed "protocarnivory" (Darwin 1875; Spomer 1999; Chase et al. 2009).

The three described "viscid" species of *Aulonemia* can be distinguished by the following key:

1. Culms ca. 0.5 m tall, 2–7 mm in diameter, rigid and hollow; spikelets with lemma awns 4–5.5(–7) mm long; foliage leaves narrowly lanceolate, 2–2.7 cm wide; leaf fimbriae sparse (0–2 per leaf), delicate, 4–8 mm long; Bolivia ____ **A. scripta**
1. Culms 4–5 m tall, 5–15 mm in diameter, easily crushed, pulpy and succulent; spikelets awnless; foliage leaves narrowly to broadly ovate, 4–8 cm wide; leaf fimbriae either absent or well-developed (15–30 mm long); Costa Rica
    2. Leaves with fimbriae well-developed, 15–30 mm long, the blades broadly ovate, 4–8 cm wide; peduncles and inflorescence branches not viscid; spikelets not maculate, 25–40 mm long ____ **A. patriae**
    2. Leaves efimbriate, the blades narrowly ovate, 4–5 cm wide; peduncles and inflorescence branches viscid; spikelets purple-maculate, 15–25 mm long ____ **A. viscosa**

Aulonemia scripta is assessed as Critically Endangered because its EOO (extent of occupancy) is (as far as is known) less than 100 km^2, and it is only known to occur at a single location; thus, criterion CR B1a of the IUCN (2001) applies.

ACKNOWLEDGMENTS

We thank UWSP student Eva C. Hathaway for the line drawings, Sol Sepsenwol for assistance in scanning electron microscopy, Gerrit Davidse and James Solomon for the loan of specimens from MO, Virginia Freire for assistance with the Spanish abstract, and Lynn G. Clark and Ximena Londoño for helpful reviews, and Mónica Moraes (Directora, Herbario Nacional de Bolivia) for confirming the LPB holotypes.

REFERENCES

Calderón, C.E. and T.R. Soderstrom. 1980. The genera of Bambusoideae (Poaceae) of the American continent: keys and comments. Smithsonian Contr. Bot. 44:1–27.

Chase, M.W., M.J.M. Christenhusz, D. Saunders, and M.F. Fay. 2009. Murderous plants: Victorian Gothic, Darwin and modern insights into vegetable carnivory. Bot. J. Linnaean Soc. 161:329–356.

Clark, L.G. 1989. Systematics of *Chusquea* section *Swallenochloa*, section *Verticillatae*, section *Serpentes*, and section *Longifoliae* (Poaceae: Bambusoideae). Syst. Bot. Monogr. 27:1–127.

Clark, L.G. 2004. New species of *Aulonemia* and *Chusquea* (Poaceae: Bambusoideae: Bambuseae) from southeastern Brazil. Rev. Bras. Bot. 27:31–36.

Clark, L.G., E.J. Judziewicz, and C.D. Tyrrell. 2007. *Aulonemia ximeniae* (Poaceae: Bambusoideae: Bambuseae), a new species from Colombia and Venezuela. Bamboo Sci. Cult. 20:1–6.

Clark, L.G. and X. Londoño. 1990. Three new Andean species of *Aulonemia* (Poaceae: Bambusoideae). Ann. Missouri Bot. Gard. 77:353–358.

Clark, L.G., X. Londoño, and M. Kobayashi. 1997. *Aulonemia bogotensis* (Poaceae: Bambusoideae), a new species from the Cordillera Oriental of Colombia. Brittonia 49:503–507.

Clayton, D.K. and S.A. Renvoize. 1986. Genera graminum: grasses of the world. Her Majesty's Stationery Office, London.

Darwin, C. 1875. Insectivorous plants. J. Murray, London.

Ellis, R.P. 1979. A procedure for standardizing comparative leaf anatomy in the Poaceae. II. The epidermis as seen in surface view. Bothalia 12:641–671.

IUCN, 2001. IUCN Red List categories and criteria, Version 3.1. International Union for the Conservation of Nature Species Survival Commission. IUCN, Gland, Switzerland, and Cambridge, United Kingdom.

Judziewicz, E.J. 2005. *Aulonemia nitida* (Poaceae: Bambusoideae), a new species from Guyana. Sida 21: 1263–1267.

Judziewicz, E.J., L.G. Clark, X. Londoño, X., and M.J. Stern. 1999. American bamboos. Smithsonian Institution Press, Washington, DC. vii+392 pp.

Judziewicz, E.J., G. Davidse, and L.G. Clark. 1991. Six new bamboos from the Venezuelan Guayana. Novon 1:76–87.

Judziewicz, E.J. and R. Riina. 2005. *Aulonemia dinirensis* (Poaceae: Bambusoideae: Bambuseae), a new dwarf Venezuelan species from the easternmost Andean páramos. Bamboo Sci. Cult. 19(1):11–15.

Judziewicz, E.J., R.J. Soreng, G. Davidse, P. Peterson, T.S. Filgueiras, and F.O. Zuloaga. 2000. Catalogue of New World Grasses (Poaceae): I. Subfamilies Anomochlooideae, Bambusoideae, Ehrhartoideae, and Pharoideae. Contr. U.S. Natl. Herb. 39:1–128.

Judziewicz, E.J. and C.D. Tyrrell. 2007. *Aulonemia yanachagaensis* (Poaceae: Bambusoideae: Bambuseae), a new species from Peru. *Brittonia* 59:83–87.

McClure, F.A. 1973. Genera of bamboos native to the New World. Smithsonian Contr. Bot. 9:1–148.

Pohl, R.W. 1980. Family #15, Gramineae. In Flora Costaricensis. Fieldiana, Bot., n.s. 4.

Pohl, R.W. and G. Davidse. 1994. *Aulonemia*. In: Davidse, G., M. Sousa, and A.O. Chater, eds. Flora Mesoamerica. Vol. 6, Alismataceae a Cyperaceae. Universidad Autónoma de México, México, D.F. Pp. 198–199.

Renvoize, S.A. 1998. Gramíneas de Bolivia. Kew: Royal Botanic Gardens.

Spomer, G.G. 1999. Evidence of protocarnivorous capabilities in *Geranium viscosissimum* and *Potentilla arguta* and other sticky plants. Int. J. Plant Sci. 160:98–101.

Tovar, O. 1993. Las gramíneas (Poaceae) del Perú. Ruizia 13:1–480.

BOOK NOTICE

Lincoln Taiz and Eduardo Zeiger. 2010. **Plant Physiology, 5th Edition.** (ISBN 978-0-878-93866-7, hbk.). Sinauer Associates, Inc., 23 Plumtree Road, Sunderland, Massachusetts 01375, U.S.A. (**Orders:** www.sinauer.com). $124.95, 782 pp., 593 illus., selection of color figures, SEM images, graphs, tables, images and appendices, 9" × 11 ¼".

Chapters:

1. Plant Cells
2. Genome Organization and Gene Expression
3. Water and Plant Cells
4. Water Balance of Plants
5. Mineral Nutrition
6. Solute Transport
7. Photosynthesis: The Light Reactions
8. Photosynthesis: The Carbon Reactions
9. Photosynthesis: Physiological and Ecological Considerations
10. Translocation in the Phloem
11. Respiration and Lipid Metabolism
12. Assimilation of Mineral Nutrients
13. Secondary Metabolites and Plant Defense
14. Signal Transduction
15. Cell Walls: Structure, Biogenesis, and Expansion
16. Growth and Development
17. Phytochrome and Light Control of Plant Development
18. Blue-Light Responses: Morphogenesis and Stomatal Movements
19. Auxin: The First Discovered Plant Growth Hormone
20. Gibberellins: Regulators of Plant Height and Seed Germination
21. Cytokinins: Regulators of Cell Division
22. Ethylene: The Gaseous Hormone
23. Abscisic Acid: A Seed Maturation and Stress-Response Hormone
24. Brassinosteroids: Regulators of Cell Expansion and Development
25. The Control of Flowering
26. Responses and Adaptations to Abiotic Stress
Appendix One: Energy and Enzymes
Appendix Two: The Analysis of Plant Growth
Appendix Three: Hormone Biosynthetic Pathways
Glossary
Author Index
Subject Index

This textbook provides a novice student or botanist with enough information regarding plant physiology. The authors include a variety of color images, graphs, and figures to assist in the explanation of the many processes that occur within plants. Taiz and Zeiger added several new features to this edition: new chapters (Chapters 2 and 14), a new appendix (3), updates and revisions to the information included in various chapters, and updates to the supplemental information included on the companion website (www.plantphys.net). The companion website is easy to navigate and provides additional information that helps to clarify certain points in the chapters. These enhancements have greatly improved the book since its first edition. The figures that they used are quite detailed and easy to follow.—*Keri McNew Barfield, MS Biology, Research Programs Manager, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

A NEW *LEUCOPHYLLUM* (SCROPHULARIACEAE) FROM SONORA, MEXICO

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ABSTRACT

A new species, **Leucophyllum mojinense,** is described from oak woodlands northeast of Álamos, Sonora, Mexico, in a habitat unlike that of the other desertic-scrub-chaparral species. Commensurately the species is distinguished by a more open, non-thorny branching, much larger leaves, flowers and fruit. In these features it is unlike all other species in the genus.

RESUMEN

Se describe una especie nueva para la ciencia, **Leucophyllum mojinense,** proveniente de los bosques de encino al noreste de Alamos, Sonora, México, en un hábitat diferente al de matorral desértico o de chaparral de las demás especies del género. Dado este hábitat menos xerofítico, no es sorprendente que la especie nueva se distinga fuertemente de las demás por su ramificación más abierta y no espinosa, y por sus hojas, flores y frutos mucho más grandes.

INTRODUCTION

Collections from near Álamos, Sonora, Mexico has revealed a distinctive new species of *Leucophyllum*. It is similar to other *Leucophyllum* species in all critical features, e.g., in having exstipulate leaves, dendritic vegetative vestiture, ebracteate flowers with separate sepals, didynamous stamens, partially adnate filaments, anthers with parallel anther sacs with the outermost sac connected across the anther tip, and sympetalous, funnelform, weakly zygomorhic, blue-purple corollas that are orange spotted on the throat floor and pilose within.

All other species of *Leucophyllum* occur in habitats marginal to and above deserts, (in mixed desert scrub, yucca woodland, izotal, thorn scrub) from trans-Pecos, central and southeastern Texas southward through east and central Mexico to Oaxaca (Henrickson & Flyr 1985). However, the new taxon occurs far to the west in a seasonally more mesic, usually frost-free oak woodland on the west slopes of the Sierra Madre Occidental in southeastern Sonora (Martin et al. 1998). And while all other species of *Leucophyllum* are strongly branched, sometimes thorny shrubs with small leaves, the new species is sparsely, more openly branched, with thicker young stems, larger leaves, flowers and fruit, all features showing adaptation to this novel, more mesic habitat.

DESCRIPTION

Leucophyllum mojinense Henrickson & T.R. Van Devender, sp. nov. (**Figs. 1, 2**). TYPE: MEXICO. SONORA: Mpio. Álamos, mesas above Arroyo Hondo, ca. 7.0 km below (SW of) Rancho Santa Bárbara, Rancho Ecológico Monte Mojino, 33 (road) km ENE of Álamos, uncommon shrub, 1 m tall, flowers purple, oak woodland, 27°05'58"N, 108°44'06"W, 1200 m, Mar 2009, *D. Sauceda & S. A. Meyer* s.n. (HOLOTYPE: ARIZ; ISOTYPES: MEXU, TEX, USON).

Species haec ab speciebus aliis Leucophyllo differt in ramificatione magis apertis caulibus ad 3–5 mm in diametro, foliorum ellipticibus grandioribus 25–56 mm longis atque 11–38 mm latis, corollas longioribus 35–40 mm per totam longitudinem cum pilis dendriticis, cellulis inflatis parietibus tenuibus supra epidermidem elevatis, et capsulis grandioribus ad 8 mm longis.

Coarsely branched shrubs to 10+ dm tall; stems mostly erect-ascending, branched from near base, less so above; young stems ± 2 mm diameter, terete, white pannose with dense, appressed, thin-walled, branched hairs; older stems 3–5 mm diameter, with vestiture tardily diminished; basal stems to 1.4 cm diameter, periderm gray to dark gray; internodes 2–9 mm long. Leaves alternate, subopposite, rarely some opposite, erect-ascending, thickish, elliptical, broadly elliptical to obovate, ovate in sucker shoots, (25–)32–56 mm long, 11–22(–38) mm wide, acute to obtuse-rounded, abruptly apiculate at the tips, narrowly cuneate above

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Fig. 1. *Leucophyllum mojinense*. **A.** Photo of flowering branch, with an oblique view of an open flower as seen from below and forward. The abaxial petal shows a well developed pilose vestiture; also shown are mature elliptical, leaves. Background plant is the same species showing stems and leaves. **B.** Same flower (lateral view) showing tube and flairing of petal lobes, note open fruit below flower. **C.** Leaves of a sucker shoot at plant base showing larger, more ovate leaves and white vestiture. A.–B. ± ×0.7; C. ± ×0.5. A.–B. photos by M.G. Figueroa-Martínez, Jul 2005; C. by G.M. Gienger, 22 Aug 2007.

decurrently winged petioles 4–5(–10) mm long at the bases, entire, isobilateral, the surfaces of young leaves ± silvery white pannose with a moderate vestiture of irregular, dendritically branched, multicellular hairs, the upper hair segments thin walled, expanded, mostly paralleling epidermis, elevated above the leaf surface by short, vertical basal segments, the vestiture diminishing in older leaves; midveins conspicuously raised, white beneath, impressed to narrowly grooved on the adaxial surface and this groove continuing down petiole, the axil of each leaf developing a densely pannose, short-stalked flower bud 4.5–7+ mm long. Flowers

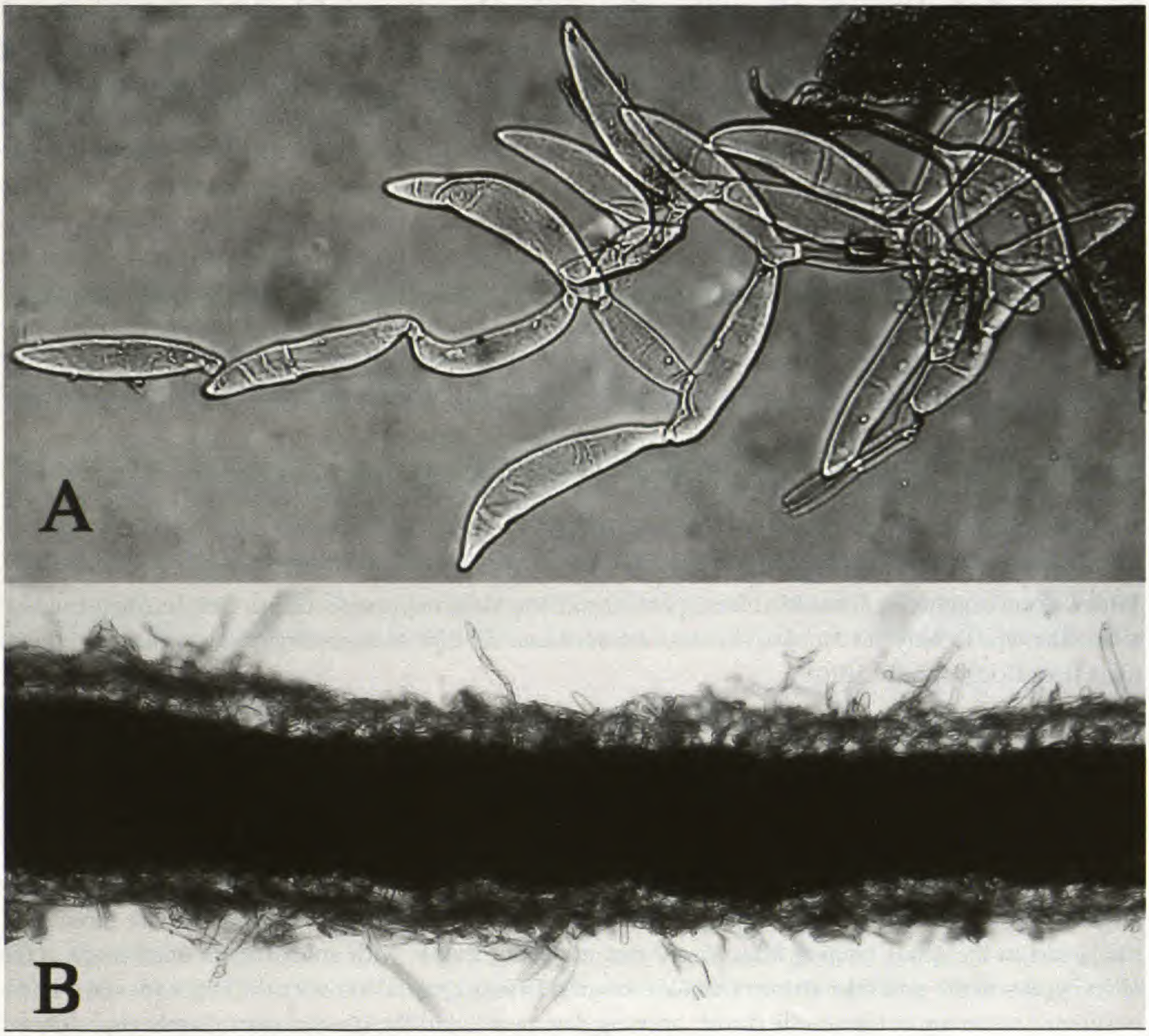

Fig. 2. *Leucophyllum mojinense* vestiture. A. Mass of distally branched, horizontally oriented cells of leaf trichomes. The individual cells range from 100–160 µm in length. B. Cross section of leaf blade (± 1/3 mm thick) showing erect basal cells of trichomes (± 14–20 µm tall) upon which the distal cells lay horizontally.

solitary, axillary; pedicels 2–5 mm long, 1–1.2 mm wide, pannose; calyx 9–11 mm long; sepals 5, lanceolate, 6–11 mm long, to 2.5–3 mm wide above the thickened base, the outer sepals ± broader than the inner, thick keeled, tapered to thickish, obtuse to acute tips, ± pannose-floccose outside, stipitate glandular inside, the inner sepals with shaggy matted marginal hairs to 1 mm long, the sepals straight and persisting around fruit. Corollas ascending, 35–40 mm long, the basal tube (that enclosed in the calyx) 6–7 mm long, ± 4–5 mm diameter, thickened, narrowly invaginated where adnate to filament bases, expanding above sepals to a broadly, slightly ampliate throat 18–22 mm long, to 8–11 mm in diameter, the 5 lobes rounded, 9–12 mm long, 9–10 mm wide, entire, rounded or the abaxial most minutely apiculate at the tip, spreading-upcurved (2 adaxial, 2 lateral and one abaxial), glabrous except where pilose with unicellular hairs to 2 mm long, 0.1 mm wide on the abaxial lobe and distal-mid tube-throat within, the tube whitish, striped with blue-purple outside, with rows of orange spots on the mid-basal, abaxial corolla throat within, the lobes stronger blue-purple; stamens 4, included, didynamous, (the adaxial-most, fifth stamen absent); adaxial (posterior-lateral) paired filaments 18–21 mm long, adnate to corolla tube base for 10–11.5 mm, the free filaments 8–10 mm

long ± 1.3 x 0.7 mm thick, positioning the introrse anther along the roof of the corolla throat about 5–6 mm below the corolla lobes, the abaxial (anterior-lower) filaments 15–17 mm long, adnate to corolla tube base for 8–10 mm, the free filament 6–8 mm, ± 0.5 mm in diameter, positioning the introrse anthers at the base floor of the tube throat proximal to the other pair, the filaments white, glabrous; anthers cream white, anther sacs oblong, the adaxial pair 4.5–5 mm long, ± 1.2 mm in total width, the abaxial pair ± 2.5 mm long, 1–1.2 mm in total width, the anther sacs initially parallel, the outer sac continuous around the tip, the paired anther sacs diverging at anthesis, those of the adaxial stamens drying peltately explanate. Ovaries superior, weakly stipitate glandular near the tip; styles 19–21 mm long, glabrous, exserted well beyond the anthers; stigmas narrowly compressed lanceolate, 1.5–2.8 mm long, to 0.7 mm wide, acute, opening at anthesis, stigmatic along the margins. Fruit brownish, ligneous, broadly ovoid, ± 8 mm long, to 5–6 mm wide, acuminate, opening along 4 distal sutures; seeds numerous, yellowish-tan, irregularly angular by compression, blunt at the ends, 0.9–1 mm long, 0.4–0.5 mm wide, the surfaces with a fine hexogonal pattern. All flower measurements are from rehydrated herbarium material.

Paratypes. All from the same population. **MEXICO. Sonora:** Mcpio. de Álamos, Mesa above Arroyo Hondo, ca. 7.0 km below (SW) of Rancho Santa Bárbara, 33 km ENE of Álamos (by road); oak woodland, ca. 27°05'58"N, 108°44'06"W, 1200 m, 8 Sep 2005, *M.G. Figueroa-Martínez s.n.* (ARIZ, TEX); same location, 2 Oct 2006, *M.G. Figueroa-Martínez s.n.*, (ARIZ); same location and date, *A.L. Reina, G. 2006-1064, with T. R. Van Devender, M.A. Dimmitt*, (ARIZ, TEX); same location, Aug 2007, *G.M. Gienger s.n.* (CAS, MO, NMC, USON).

With flowers in July (Figueroa-Martinez's photos) and late March (type collection); fruit in August to October. The type locality lies 21.5 km (by air), east-northeast (66.33°) of the central plaza in Álamos, Sonora (data from Google Earth, 2010).

DISCUSSION

Leucophyllum mojinense differs from other species of *Leucophyllum* in many features. Vegetatively it has a more open branching with prominent stems and large leaves (see the stems in the background of Fig. 1A). The stem and leaf vestiture consists of narrow-based, asymmetrically inflated cylindrical cells with very thin walls that often collapse to form a dense pannose vestiture on stems and a thinner vestiture on leaves (Fig. 2). In leaves the upper cells are horizontally suspended above broad, erect basal cells. The flowers are the largest in the genus ranging from 35–40 mm in overall length, with an extended, open throat. Like other species in the genus the stamens are didynamous, basally epipetalous, with the larger adaxial anthers positioned at the top of the corolla throat, opening downward, and the smaller abaxial anthers positioned at the base of the corolla throat, opening upward. But unlike other species the thickish basal corolla tube is deeply invaginated opposite the attachment of the filament bases. Also, the adaxial anthers are the largest in the genus and the style tip is narrowly lance-ovate.

Within *Leucophyllum*, the new species shares most characteristics with *L. hintonorum* Nesom, a species with cuneate-based leaves from gypsum habitats between Aramberri and Zaragoza, Nuevo León. But while *L. hintonorum* has moderately large leaves 20–35 mm long, and moderately large flowers 16–28 mm long with orange spots in the lower throat, it differs strongly in vestiture, growth habit, and habitat making any statement of true relationships tentative.

Etymology.—The specific epithet refers to the southern Sonora term for tropical deciduous forest, *monte mojino*, the dominant vegetation visible in the Río Cuchujaqui drainage below the type locality. *Mojino* refers to the reddish-grey color of the dry season forest. It also celebrates the name of the land where it grows, Rancho Ecológical Monte Mojino (REMM) and the efforts of Nature and Culture International, Inc. to preserve this threatened habitat.

The new species was discovered by Martín Gabriel Figueroa-Martínez on July 15, 2005 as part of a vegetation survey of the Rancho Santa Bárbara area at a site about 21 km and 66° east-northeast of Álamos in southern Sonora (Martin et al. 1998). This area is on the 6,000 hectare REMM owned by Nature and Culture International, Inc., a private non-profit organization based in San Diego, California. REMM was established in 2004 to protect tropical deciduous forest within the large (92,890 hectares) Área Protegida de Fauna and Flora Sierra de Álamos-Río Cuchujaqui.

Rancho Santa Bárbara is in a very interesting area on the western edge of the Sierra Madre Occidental. It is in the Río Cuchujaqui drainage, a major tributary of the Río Fuerte in Sinaloa. Tropical deciduous forest occurs along most of the elevational gradient in REMM from 350 m along the Cuchujaqui to 1500 m above Santa Bárbara. The type locality of *L. mojinense*, at 1200 m elevation, is in oak woodland just above tropical deciduous forest and below pine-oak forest. Two large populations are in same area on rocky poor soils referred to as sabanías. Associated species include *Quercus* spp., *Dodonaea viscosa*, *Agave bovicornuta*, *Lysiloma watsonii*, and *Ipomoea arborescens*. Darío Sauceda, who made the first collections of the taxon, noted that he has not seen the plant elsewhere in the Sierra Madre Occidental in this area in Sonora or in western Chihuahua (pers. comm. 2009 to Stephanie A. Meyer). The type of the new *Erigeron barbarensis* Nesom & T.R. Van Devender was from Arroyo Santa Bárbara 1.5 km west-northwest of the *L. mojinense* populations (Nesom & Van Devender 2007) and type locality of *Hesperaloe tenuifolia* G.D. Starr lies 1.7 km. south-southwest of the type locality of *L. mojinense* on Cerro Agujudo (Starr 1997).

ACKNOWLEDGMENTS

We thank Stephanie A. Meyer, Martín Gabriel Figueroa-Martínez, and Darío Sauceda of Rancho Ecológico Monte Mojino for calling this new species to our attention and providing specimens. We thank Mark A Dimmitt and Ana Lilia Reina-Guerrero for their comments and encouragement and Paul Fryxell for the Latin translation, Fernando Chiang for Spanish translation, Kanchi Ghandi for nomenclatural advice, Robert Harms for aligning the figures, and Richard S. Felger and an anonymous reviewer for comments on the manuscript.

REFERENCES

Henrickson, J. and D. Flyr. 1985. Systematics of *Leucophyllum* and *Eremogeton* (Scrophulariaceae). Sida 11: 107–172.

Martin, P.S., D.A. Yetman, M. Fishbein, P. Jenkins, T.R. Van Devender, and R.K. Wilson (eds.). 1998. Gentry's Río Mayo plants. The Tropical Deciduous Forest & Environs of Northwest Mexico. University of Arizona Press, Tucson.

Nesom, G.L. 1991. A new species of *Leucophyllum* (Scrophulariaceae) from Nuevo León, México. Phytologia 71:337–339.

Nesom, G.L. and T.R. Van Devender. 2007. A new species of *Erigeron* (Asteraceae: Astereae) from the Río Mayo Region of Sonora, Mexico. Phytologia 89:219–222.

Starr, G.D. 1997. A revision of the genus *Hesperaloe* (Agavaceae). Madroño 44:282–296.

BOOK REVIEW

Tracy Disabato-Aust. 2008. **50 High-Impact, Low-Care Garden Plants: Tough-but-Beautiful Plants Anyone Can Grow.** (ISBN 978-0-881-92950-8, pbk.). Timber Press Inc., The Haseltine Building, 133 S.W. Second Avenue, Suite 450, Portland, Oregon 97204-3527, U.S.A. (**Orders:** orders@timberpress.com, 1-800-827-5622). $16.95, 168 pp., 135 color photos, 7 ½" × 9".

Many people are finding modern life busy and hectic, leaving little time for hobbies such as gardening. As a result, busy gardeners are searching for fast-growing, easy-to-care-for plants. Author Tracy Disabato-Aust with her book, *50 High-Impact, Low-Care Garden Plants: Tough-but-Beautiful Plants Anyone Can Grow,* offers some helpful recommendations. There is a small section written for each plant. On the side of each section are notes on the basic information of the plant such as hardiness, height, spread, and light needs. Disabato-Aust follows each section with her low-maintenance checklist:

Long-lived
Tolerates heat and humidity
Cold-hardy
Deer-resistant
Insect and disease resistant
Minimal or no deadheading
Minimal or no fertilizing
No staking
Minimal or no division
Minimal or no pruning
Non-invasive
Drought-tolerant

This is a great book for novice gardeners or homeowners who wish to beautify their home with care-free plants. The only drawback is that the author chooses many plants suited to a Midwest climate since she lives in Ohio. However, those in other climates will still find some very suitable choices.—*Elaine Diaz, BRIT volunteer, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76106-4025, U.S.A.*

POA RAMIFER (POACEAE: POOIDEAE: POEAE: POINAE), A NEW AERIALLY BRANCHING GYNOMONOECIOUS SPECIES FROM PERU

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ABSTRACT

A new species, **Poa ramifer** Soreng & P.M. Peterson, from Ancash, Peru is described and illustrated. It differs from all other American species of *Poa* in having erect, aerially branching culms with lateral shoots that persist and flower in subsequent seasons. The spikelets of the gynomonoecious plants have proximal perfect and distal pistillate florets with dimorphic lodicules.

RESUMEN

Se describe e illustra una nueva especie, **Poa ramifer** Soreng & P.M. Peterson, del departamento de Ancash, Peru. Se diferencia de las restantes especies americanas de *Poa* por tener cañas erguidas, ramificadas, ramificaciones laterales persistentes que florecen en estaciones subsecuentes. Las plantas ginomonoicas tienen espiguillas con antecios proximales hermafroditas y antecios distales pistilados, con lodículas dimorfas.

On a high ridge above a tributary north of the canyon of the Rio Santa along the western slopes of the Andes in the Provincia de Corongo, Departamento Ancash of northern Peru, the authors in 2008 collected a *Poa* that was undoubtedly a new species. The type collection was gathered about eight km above Pilipampa, on a winding road between Bambas and Miraflores, below the pass between the provinces of Corongo and Pallasca. About 100 plants were noted in the one population we found on the south facing shrubby slopes between 2750 and 3040 m in elevation. No other stations are known for the species, but we expect the new species to be locally frequent on similar slopes in areas that have been minimally grazed by domestic animals or otherwise minimally disturbed. We have examined collections of *Poa* from South America, particularly from Peru at CPUN, MO, MOL, US, and USM [acronyms follow Thiers (2009)], but found no other collections matching the new species.

Poa ramifer Soreng & P.M. Peterson, sp. nov. (**Figs. 1 A–C, 2 A–O**). Type: PERU. Departamento Ancash: Provincia Corongo, S side of pass between Bambas (Prov. Corongo) and Miraflores (Prov. Pallasca), 8 km above Pilipampa and 17 km by road NW of Bambas (8°34'15.5"S, 78°02'33.1"W), slopes with *Baccharis*, *Salvia*, and yellow-flowered Asteraceae shrubs, 2788 m, 20 Mar 2008, *P.M. Peterson & R.J. Soreng 21804* (holotype: US!; isotypes: B!, BAA!, COL!, CONC!, CORD!, CPUN!, K!, L!, LE!, LPB!, MA!, MO!, MOL!, NY!, PE!, QCA!, SI!, US!, US!, USM!).

A Pois Americae, supernis nodis veterum erectorum florentium culmorum ramosis et floriferis differt.

Plants perennial, cespitose from broad based clumps (to 1 m diam.) with extravaginal primary shoots from a knotty base; primary roots 0.4 mm diam.; primary culms 80–100 cm tall (including panicles), erect or slightly decumbent, 1–1.5 mm diam. at base, smooth, perenniating with 7–10-leaf bearing nodes, nodes smooth, glabrous, with intravaginal and extravaginal leafy secondary shoots arising from nodes 5–60 cm above base along the primary flowering culms, secondary shoots flowering in the next season and developing a few new leafy tertiary shoots. **Leaves** mostly cauline; sheaths slender, slightly compressed, scabridulous, papery (not becoming fibrous), lower sheaths closed up to the ligule, upper sheaths 2–4 times as long as their blades, closed ca. 40% of their length, lightly scabridulous; blades 2–15 cm long, 1–2 mm wide, flat or folded on drying, thin, shallowly keeled, abaxially and adaxially scabridulous mostly over the costae, with 6 or 7 narrow and well spaced costae (intercostal area 1–3 times as wide as each costal rib) on either

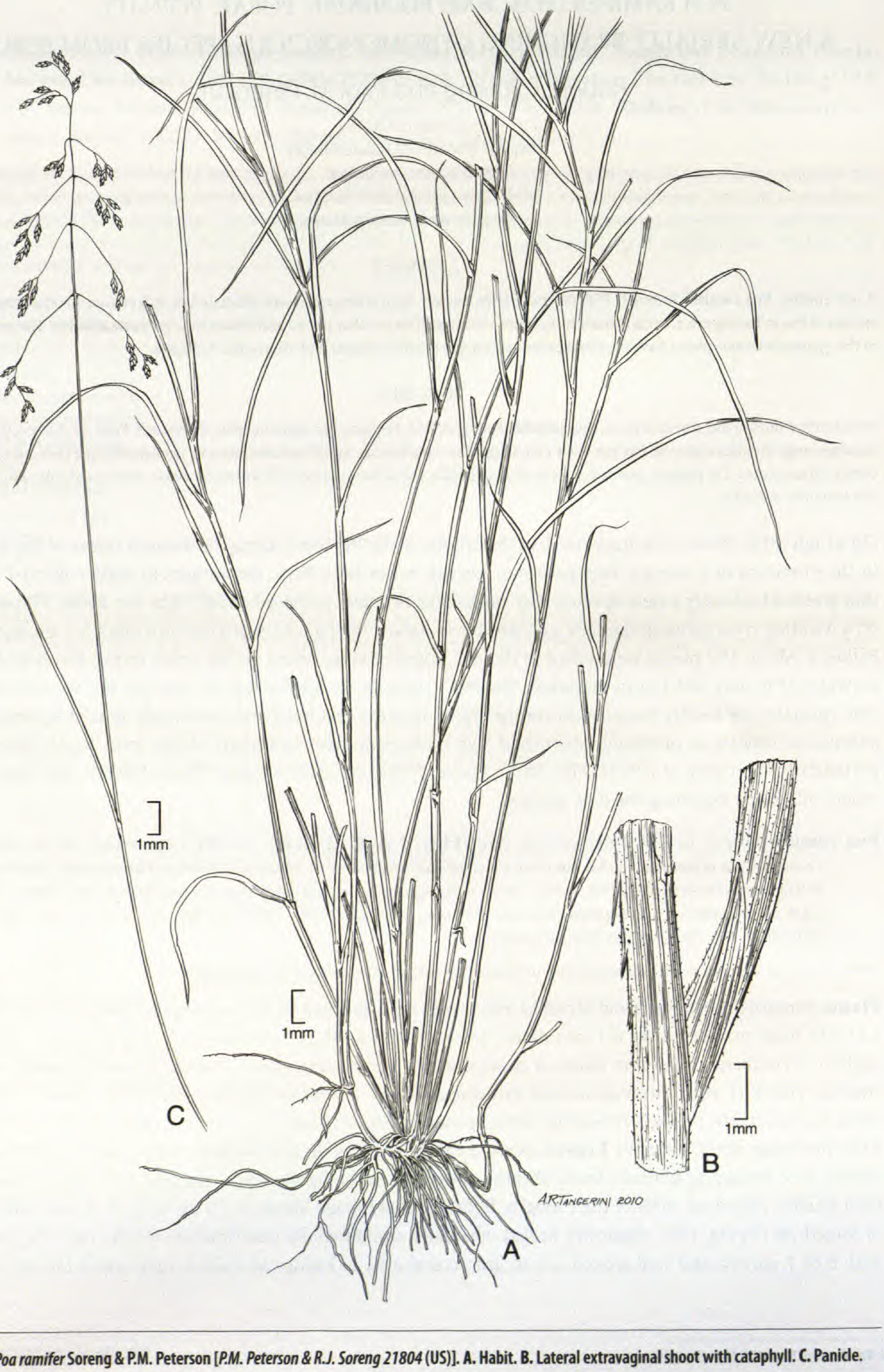

Fig. 1. ***Poa ramifer*** **Soreng & P.M. Peterson [*P.M. Peterson & R.J. Soreng 21804* (US)]. A. Habit. B. Lateral extravaginal shoot with cataphyll. C. Panicle.**

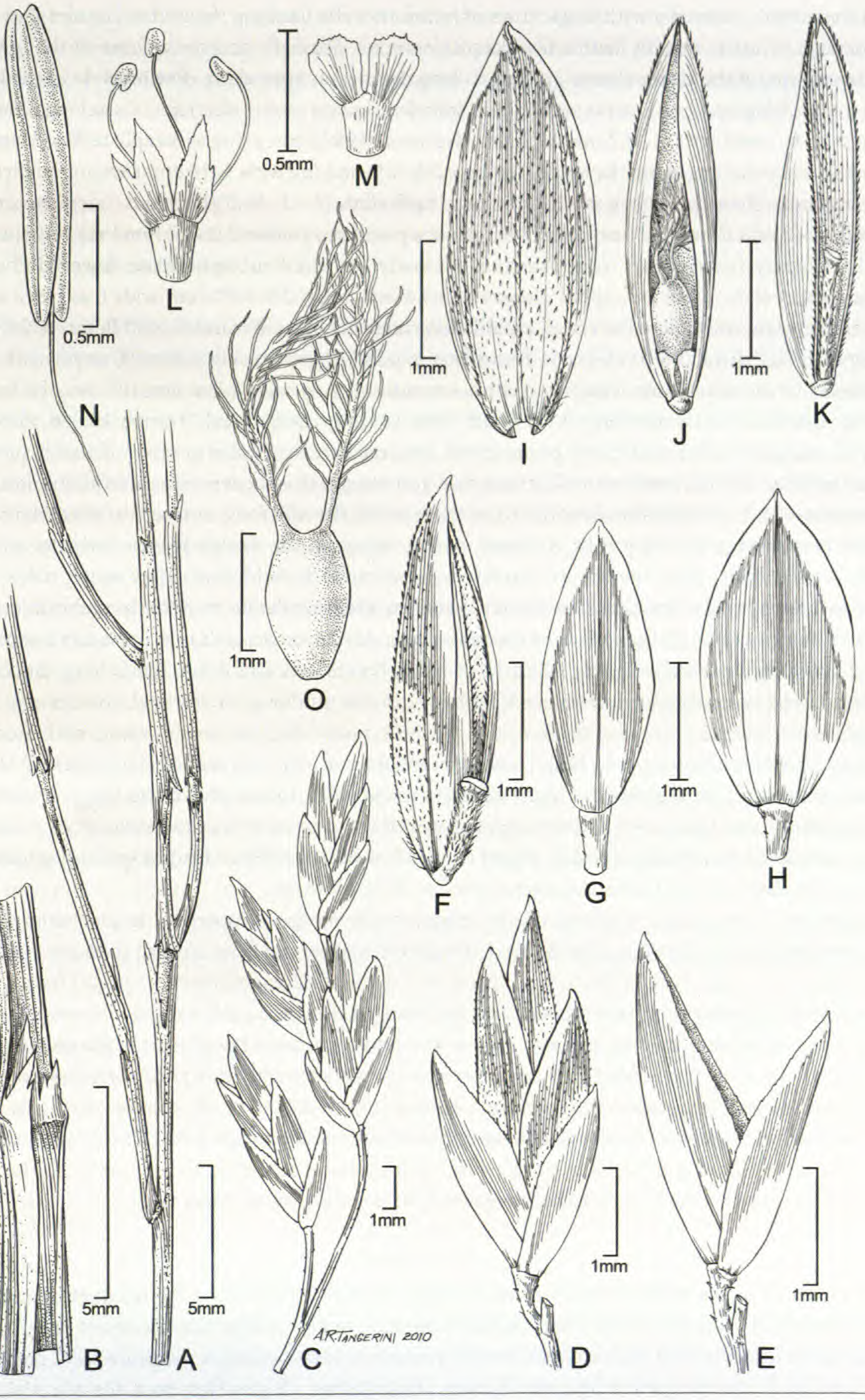

Fig. 2. *Poa ramifer* [*P.M. Peterson & R.J. Soreng 21804* (US)]. A. Extravaginal branching from old culm. B. Ligule. C. Four spikelets. D. Spikelet. E. Lower and upper glumes in lateral view. F. Proximal floret (perfect). G. Lower glume dorsal view. H. Upper glume dorsal view. I. Lemma of proximal floret, dorsal view. J. Flower (anthers removed) inside palea of proximal floret. K. Palea lateral / ventral view of proximal floret. L. Flower of distal pistillate floret, lodicules and staminodes (pistil removed). M. Lodicules of proximal floret. N. Anther of proximal floret (1 of 3). O. Pistil of distal floret.

side of the midrib, adaxially with single rows of bulliform cells flanking the midrib; ligules 2–4 mm long, membranous, whitish, usually with a few deep lacerations, abaxially scabrous, those of the lower shoots connate in front, of the upper shoots grading to long decurrent, apex acute. **Panicles** 4–10 cm long, erect except for nodding tip, open, sparse with 20–65 spikelets, lowest internodes 1.8–2.6 cm long; branches 1 or 2(–3) per node, capillary, 0.1–0.2 mm in diam., flexuous, widely spreading to steeply reflexed, sparingly to moderately scabridulous along the angles, longest 2.5–5.5 cm long with 3–10 spikelets in the distal halves; pedicels shorter than the spikelets, scabridulous. **Spikelets** (2–)3–4(–5)-flowered, laterally compressed, proximal (1–)2 or 3 florets perfect, distal 1 or 2 florets pistillate; glumes 2.2–3.2 mm long, unequal, keeled, smooth or lightly scabridulous, edges smooth to closely scabridulous, apex acute; lower glumes 2.2–2.4 mm long, lanceolate, 1-nerved; upper glumes 2.9–3.2 mm long, 0.9–1.35 mm wide, ca. twice as wide as lower, broadly lanceolate 3(or 4)-nerved; rachilla internode between first and second floret ca. 0.6 mm long, densely scabrous, distal internodes ca. 1.1 mm long, moderately to densely scabrous, terete; callus laterally compressed in the dorsal side, smooth, glabrous or infrequently with a few dorsal hairs, the hairs to 0.8 mm long; lemmas 3.3–3.8 mm long, 0.7–1.1 mm wide, laterally compressed, strongly keeled, membranous, 5-nerved, marginal veins moderately pronounced, intermediate veins obscure to moderately pronounced, margins involute and narrowly white scarious, keel and marginal veins densely scabridulous, keel glabrous or sericeous with 1-several hairs near the base, the hairs to 0.4 mm long, surface between veins lightly to moderately scabridulous, silica cells common, surface between the marginal vein and edge moderate to densely scabridulous, edge smooth or sparsely to moderately scabridulous, apex acute; paleas equaling lemma in length, keels densely scabridulous, between keels moderate to densely scabridulous, flanges smooth, about as wide as the gap between the keels; lodicules 2, obtuse, glabrous, in perfect florets lodicules 0.2–0.3 mm long, unlobed or briefly lobed, in pistillate florets lodicules 0.5–0.6 mm long, lanceolate with a distinct lateral lanceolate lobe; stamens 3; anthers 2.0–2.8 mm long, or vestigial, then ca. 0.2 mm long; ovary glabrous, styles 2, terminal, adjacent, stigmas ca. 1.5 mm long, lanceoloid, white, with moderately to densely plumose branches from the base, primary branches sparingly rebranched; caryopses 1.7–2 mm long, narrowly lanceolate, hard, greenish, tightly adherent to the palea, hilum ca. 0.2 mm long, narrowly elliptic.

Distribution and Habitat.—Shrubby upper slopes of the canyon of the Rio Santa around Cerro Santo Toribio, with *Eragrostis lurida* J. Presl, *E. pilgeri* Fedde, *E. weberbaueri* Pilg., *Festuca* sp., *Melica scabra* Kunth, *Salvia* sp., *Baccharis* sp., and other Asteraceae shrubs, 2750–3040 m.

Comments.—*Poa ramifer* might be closely related to the more widespread *P. aequatoriensis* Hack. that occurs in relatively low elevations (for *Poa*) in Colombia, Ecuador, and Peru. In Peru the latter species occurs on the Amazonian side of the Andes as far south as Ayacucho in more mesic western slopes from 2300–3500 m (Tovar 1993). *Poa aequatoriensis* is a more mesophilic species that occasionally stools, roots at the nodes, and occasionally branches along the lower culms, but it does not branch well up into the old erect culms as in *P. ramifer* (Figs. 1 & 2). In addition, *P. aequatoriensis* has panicles with ascending branches, smaller spikelets with narrower glumes (up to 0.5 mm wide), lemmas (up to 0.7 mm wide) that are distinctly pubescent along the keel, and calluses that are distinctly webbed (contrast with Figs. 1 & 2). Both species apparently exhibit the same type of gynomonoecism (type **Ib,** see discussion below), as is common in northern Andean species of *Poa*, but the fertile anthers in *P. aequatoriensis* are only about 1 mm long.

DISCUSSION

The unusual branching habit within *Poa ramifer* (Figs. 1A & B; 2A) could be the result of natural selection favoring longevity of culms in the lower elevation habitats in Peru where few species of *Poa* occur. Of the 2990 grass collections PMP with collaborators have made in Peru between the years 1997 and 2008, 421 collections are of *Poa* (not including *Aphanelytrum, Dissanthelium, Tovarochloa*; see Gillespie et al. 2008: Although these genera are resolved within *Poa* in DNA analyses, they have not yet been transferred). Of these only eight *Poa* collections (including *P. ramifer*) were made below 3000 m, and of these only three were found below 2900 m. Even though species of subfamily Chloridoideae often dominate the lower elevations

of the coastal slopes of the Andes, vegetation is extremely sparse below 2000 m, except in riparian habitats. These open, low elevation slopes are evidently extremely xeric and not well suited for *Poa*. Temperatures at the type locality of *Poa ramifer* probably never drop below freezing [location of the type is well within the low of 0–4°C minimum temperature zone, and near the 4–8°C minimum; Servicio Nacional de Meteorología e hidrología del Perú (2009) website map], and cloud banks regularly occur in this zone (we saw a cloud bank and photographed it during our trip) providing humidity, dew, and infrequent rains, at least during the wet season. This habitat may have favored the development of above ground culms that persist in this species, as it has for species restricted to loma habitats of low elevations near the Pacific coast (Ferreyra 1953, e.g., *Oxalis gigantea* Barnéoud).

There are now 34 species of *Poa* (including *P. ramifer*) accepted for Peru by Soreng et al. (2003, updated on-line version, see 2009b). We predict that the new species belongs to the large, world-wide *Poa* subg. *Poa* supersect. *Homalopoa* (Dumort.) Soreng & L.J. Gillespie based on its absence of rhizomes, relatively closed and compressed sheaths, distinct lemma nerves, and scabrous palea keels (preliminary nuclear rDNA sequence data supports this placement; Lynn Gillespie, pers. comm.). Based on morphological characteristics, all native Peruvian species of *Poa* belong to supersect. *Homalopoa*. DNA sequences of 2/3 of the indigenous Peruvian *Poa* species (not including the new species) have been phylogenetically examined (Refulio-Rodríguez 2007; Gillespie et al. 2008; L. Giussani, L. Gillespie, M.A. Negritto, N.F. Refulio-Rodríguez, R.J. Soreng unpubl. data), and none have aligned outside of the group that we interpret as *P.* supersect. *Homalopoa*. The new species is most obviously distinct from all other species of *Poa* of the Americas in its peculiar branching habit. Individual plants of *P. ramifer* form large broad-based clumps (to 1 m diam at base), with 7–10-noded erect culms reaching one meter in height that are partly supported by shrubs (Fig. 3). A panicle terminates the main culm or terminates lateral shoots that originate well up along the previous season's culm (unusual within the genus). A similar aerial branching habit is known from a few Australian species of *Poa* supersect. *Homalopoa* sect. *Brizoides* Pilg. s.l. (e.g., *P. homomalla* Nees), and a few others in *P.* sect. *Brizoides* subsection *Australopoa* Soreng, L.J. Gillespie & S.W.L. Jacobs (e.g., *P. tenera* Hook. f., *P. jugicola* D.I. Morris, and *P. orthoclada* N.G. Walsh; Gillespie et al. 2009, Soreng et al. 2009a), but this habit has presumably been derived independently in Peru. Unlike two other South American species of *Poa* (*P. hieronymi* Hack. and *P. myriantha* Hack.) with long straggling multi-noded culms to 2 m, *P. ramifer* has anthers that are 2 mm long in the perfect florets (versus stamens 1 mm long in the perfect florets), calluses that are glabrous (infrequently with 1 or 2 short hairs present; versus web well developed), panicles that are 5–10 cm long with 20–65 spikelets (versus 20–36 cm long panicles with more than 100 spikelets), and erect culms that perenniate with new flowering culms arising from the upper nodes.

The assessment of the breeding system of the new species is a bit preliminary. Although the species was more common upslope, we only collected specimens from a few plants of *P. ramifer* as these were not common where we stopped. The plants collected were gynomonoecious, within the spikelets with the proximal 2 or 3 florets perfect and the distal 1 or 2 florets pistillate. Apparently the distal pistillate flowers produce seed, but only partially developed caryopses were found in the "perfect" flowers. This arrangement of sexes appears to fit one of four types of gynomonoecism detailed by Connor (1979; type **Ib** as outlined by Soreng & Keil 2003) where spikelets consistently contain proximal perfect florets and distal pistillate florets. This type of gynomonoecism is present in at least 20 South American species of *Poa* (Anton & Connor 1995; Negritto & Anton 2000), although a few South American species of the genus exhibit a separate type called sequentially adjusted (as opposed to fixed types recognized by Connor 1979) gynomonoecism (Soreng & Keil 2003; e.g. *P. fibrifera* Pilg., *P. plicata* Hack., *P. horridula* Pilg.), wherein the frequency of pistillate flowers and spikelets increases through the season in some proportion of individuals within a population (best documented in North American species such as *P. cuspidata* Nutt. and *P. tracyi* Vasey). Further study of individuals of *P. ramifer* is needed to confirm whether the species is fixed or sequentially gynomonoecious (Soreng & Keil 2003), as there is extensive variation in breeding systems in *Poa* (Anton & Connor 1995), even within gynomonoecious species (Connor 1979; Negritto & Anton 2000; Soreng & Keil 2003).

Fig. 3. Habit of *Poa ramifer* [*P.M. Peterson & R.J. Soreng 21804* (US)] in situ. Photo by R.J. Soreng.

This is the first time in *Poa*, so far as we are aware, that different lodicule forms within a spikelet have been noted between florets. In *P. ramifer* the lodicules are present but reduced in the proximal perfect florets in each spikelet, while these structures are fully developed in the distal floret(s) within the same spikelet. In the perfect florets the lodicules are short, blunt and unlobed (Fig. 2J & M), whereas lodicules of the pistillate florets are lanceolate and lobed (Fig. 2L) as is typical of most species of *Poa*. We know of no previous documentation of morphological dimorphism of the lodicules between pistillate and perfect florets within the same species of *Poa*. In the Chilean dioecious species, *P. cumingii* (sect. *Dioicopoa* E. Desv.) Trin., lodicules are absent or poorly developed in staminate florets and well developed in pistillate florets (RJS, pers. obs.). Lodicules in monoecious and dioecious species in some grass genera (e.g., *Pharus* and *Leptaspis*, and *Bouteloua*, respectively) are well developed in staminate florets but absent in pistillate florets (Judziewicz 1987; Kinney et al. 2008). In some gynodioecious species of *Cortaderia*, lodicules are longer in pistillate plants than in hermaphroditic plants (Connor 1973). These patterns seem to be diverse. Lodicules are thought to be involved in opening the grass floret at flowering. Why lodicules should be morphologically dimorphic between proximal perfect and distal pistillate florets within the same spikelet in this new species of *Poa*, and whether the pattern in *P. ramifer* occurs in related species, requires further study.

The habit of the new species is quite the opposite of the newly described *Poa unispiculata* Davidse, Soreng & P.M. Peterson (2010). The latter species grows in the Altiplano of Departamento Pasco, Peru, at ca. 4400 m. *Poa unispiculata* forms dense mats to 19 cm in diameter, is only 2 cm tall, and has inflorescences with a single spikelet and upwards of 200 inflorescences per individual. *Poa unispculata* is gynodioecious with some plants that are pistillate and other plants that have perfect spikelets. As different as these two species may appear (see Davidse et al. 2010, Fig. 3), they have some similarities in growth form. The dwarf species (*P. unispiculata*) has many culm leaves/nodes (averaging 20–30) along the flowering culm with extremely short internodes (ca. 1 mm long). In this species the initial culms are prostrate or ascending, emerging within or at the edges of the mat, while the old culms from previous seasons produce adventitious roots at some of the older nodes. Just above some of the older nodes a succession of additional intravaginal leafy shoots are produced and many of these form new inflorescences, and so on, as the mat expands over time. Do the similarities in branching habit indicate a close phylogenetic relationship between these two Peruvian species? We hope to test this hypothesis by adding *P. ramifer* and *P. unispiculata* to our growing library of DNA sequence for the genus.

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REFERENCES

Anton, A.M. and H.E. Connor. 1995. Floral biology and reproduction in *Poa* (Poeae: Gramineae). Austral. J. Bot. 43:577–599.

Connor, H.E. 1973. Breeding systems in *Cortaderia* (Gramineae) Evolution 27:663–678.

Connor, H.E. 1979. Breeding systems in the grasses: a survey. New Zealand J. Bot. 17: 547–574.

Davidse, G., R.J. Soreng, and P.M. Peterson. 2010. *Poa unispiculata*, a new gynodioecious species of cushion grass from Peru with a single spikelet per inflorescence (Poaceae, Pooideae, Poeae, Poinae). J. Bot. Res. Inst. Texas. 4:37–44.

Ferreyra, R. 1953. Comunidades de vegetales de algunas lomas costaneras del Perú. Estac. Exp. Agrícola "La Molina," Bol. 53:1–88.

Gillespie, L.J., R.J. Soreng, R.D. Bull, S.W.L. Jacobs, and N.F. Refulio-Rodríguez. 2008. Phylogenetic relationships in subtribe Poinae (Poaceae, Poeae) based on nuclear ITS and plastid *trnT-trnL-trnF* sequences. Botany 86:938–967.

Gillespie, L.J., R.J. Soreng, and S.W.L. Jacobs. 2009. Phylogenetic relationships of Australian *Poa* (Poaceae: Poinae), including molecular evidence for two new genera, *Saxipoa* and *Sylvipoa*. Austral. Syst. Bot. 22:413–436.

Judziewicz, E.J. 1987. Taxonomy and morphology of the tribe Phareae. PhD Dissertation, University of Wisconsin, Madison.

Kinney, M.S., J.T. Columbus, and E.A. Fariar. 2008. Unisexual flower, spikelet, and inflorescence development in monoecious/dioecious *Bouteloua dimorpha* (Poaceae, Chloridoideae). Amer. J. Bot. 95:123–132. 2008

Negritto, M.A. and A.M. Anton. 2000. Revision de las especies de *Poa* (Poaceae) del noroeste argentino. Kurtziana 28:95–136.

Refulio-Rodríguez, N.F. 2007. Systematics of *Dissanthelium* Trin. PhD Dissertation, Claremont Graduate University, Claremont, California.

Servicio Nacional de Meteorología e hidrología del Perú (SENAMHI). 2009. http://www.senamhi.gob.pe/ (web-site maps accessed Dec. 2009).

Soreng, R.J., L.J. Gillespie, and S.W.L. Jacobs. 2009a. *Saxipoa* and *Sylvipoa* – two new genera and a new classification for Australian *Poa* (Poaceae: Poinae). Austral. Syst. Bot. 22:401–412.

Soreng, R.J., L.M. Giussani, and M. Negritto. 2003 [updated on line]. *Poa* L. In: R.J. Soreng, P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras, and O. Morrone, eds. Catalogue of New World grasses (Poaceae): IV. subfamily Pooideae. Contr. U.S. Natl. Herb. 48:505–580.

Soreng, R.J. and D. Keil. 2003. Sequentially adjusted sex-ratios in gynomonoecism, and *Poa diaboli* (Poaceae), a new species from California. Madroño 50:300–306.

Soreng, R.J., G. Davidse, P.M. Peterson, F.O. Zuloaga, E.J. Judziewicz, T.S. Filgueiras, and O. Morrone. 2009b. Catalogue of New World grasses. http://www.tropicos.org/Project/CNWG [2 Oct 2009, continually updated]

Thiers, B. 2009. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/ih/ [continually updated]

Tovar, O. 1993. Las Gramineas (Poaceae) del Peru. Ruizia 13:1–480.

TWO NEW ANDEAN SPECIES OF *SOLANUM* SECTION *CRINITUM* (SOLANACEAE)

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ABSTRACT

Two new species of *Solanum* section *Crinitum* are described here from the eastern slopes of the Andes and adjacent lowlands. **Solanum cyathophorum** M. Nee & Farruggia closely resembles *S. altissimum* and *S. kioniotrichum*, but differs from the other two by the presence of truncate calyx lobes. **Solanum adenobasis** M. Nee & Farruggia has close affinities to *S. grandiflorum* and *S. acanthodes* but differs from the latter two species in having short but prominent glandular hairs emerging from the base of the long stalk of the stellate hairs found along the stem and adaxial surface of the petiole.

RESUMEN

Se describen dos especies nuevas de *Solanum* sección *Crinitum* de las laderas orientales de los Andes y tierras bajas adyacentes. **Solanum cyathophorum** M. Nee & Farruggia se asemeja a *S. altissimum* y *S. kioniotrichum*, pero se distingue de las dos por los lóbulos truncados del cáliz. **Solanum adenobasis** M. Nee & Farruggia se parece a *S. grandiflorum* y *S. acanthodes* pero se diferencia de éstas por los pelos glandulares cortos pero prominentes en la base de los pelos estrellados con estipes largos que se encuentran en las ramas y superficie adaxial de los pecíolos.

KEY WORDS: *Solanum*, Andes, new species

The economically important genus *Solanum*, which includes tomato (*S. lycopersicum*), potato (*S. tuberosum*), and eggplant (*S. melongena*), has been a subject of taxonomic study for hundreds of years. It is currently the focus of an initiative to provide online descriptions and taxonomic information for all *Solanum* species (the PBI *Solanum* project; www.solanaceaesource.org). Herbarium surveys and revisionary studies on *Solanum* section *Crinitum* Whalen ex A. Child as well as new field work conducted as part of this project have identified two undescribed species within the section, which are treated below.

Solanum section *Crinitum* is part of the species-rich subgenus *Leptostemonum* (Dunal) Bitter, recognized as a group by Linnaeus (1753) on the basis of prickles ("spines") and colloquially known as the "spiny solanums." By the mid-1800s, the subgenus had been well-differentiated from other groups of *Solanum* by the combination (with very few exceptions) of the presence of prickles, tapered anthers, and, stellate hairs. Modern molecular studies have sampled many species, and subgenus *Leptostemonum* almost perfectly coincides with the informally named Leptostemonum Clade (Bohs 2005; Levin et al. 2006). Current phylogenetic evidence (Levin et al. 2006; F.T. Farruggia and L. Bohs, unpublished data) supports sect. *Crinitum* as a monophyletic group, and the molecular data of Levin et al. (2006) suggest that it may be closely related to sect. *Androceras* (Nutt.) Marzell.

Species of section *Crinitum* are distinguished from the other spiny solanums due to the fact that they are primarily medium to large trees with large purple flowers. Their fruits range in size from approximately 1 to 15 cm in diameter and have a swollen to knobby calyx at maturity. The juvenile plants are usually densely covered with broad-based prickles, and some have leaves approaching 1.5 m in length. The group as circumscribed by Whalen (1984) and Nee (1999) includes from 8 to 14 species. One of these species, *S. mitlense* Dunal, only tentatively placed in this section (Nee 1999), is endemic to Mexico while the rest

are restricted to tropical South America, with highest diversity along the wet tropical eastern slopes of the Andes.

Solanum cyathophorum M. Nee & Farruggia, sp. nov. (**Fig. 1**). TYPE: ECUADOR. NAPO: 8 km río abajo de Puerto Misahualli, por el Río Napo y 1.5 km al sur, 01°04'S, 77°36'W, 450 m, 25 May 1985, *D. Neill, W. Palacios & J. Zaruma 6506* (HOLOTYPE: QCNE; ISOTYPES: MO, NY, QAME).

Arbor, 3–10(–20) m × ca. 60 cm diametro, truncus aculeis crassis armatus, flores magnae, corollis 4.5–5 cm diametro, stellatis ad rotato-stellatis, fructus globosus, glaber, 1–1.9 cm diametro. *Solano altissimo* et *S. kioniotricho* affinis sed calycibus cupulatis lobis truncatis ad apices et corollis in alabastro manifestis differt.

Tree 3–10(–20) m × ca. 60 cm dbh. Trunk with sharp, stout broad-based prickles, the bark light tan to dark, wrinkled in vertical ridges, the slash soft, white with yellow fibers; flowering stems unarmed, glabrous to densely pubescent with sessile to short-stalked light tan multangulate-stellate hairs, the multangulate apex 0.1–0.3 mm in diameter, the rays 7–10+. Sympodial units difoliate, geminate. Leaves simple, the blades 15–30 × 7–15 cm or more, ca. 2 times as long as wide, elliptic to lanceolate, chartaceous to subcoriaceous, slightly discolorous, the fresh and dried leaves dark green and somewhat shiny adaxially, lighter green to golden-tan abaxially, the adaxial surface nearly glabrous to moderately pubescent with stalked reduced-stellate hairs, the stalks ca. 0.1–0.3 mm, multiseriate at the base, rays 1(–2), eglandular, the abaxial surface mostly densely pubescent with golden-tan sessile to multiseriate-stalked porrect-stellate hairs, the stalks 0–0.03 mm, the rays 5–8, the midpoints absent; major veins 8–9 on either side of midvein; base cuneate to oblique; margin entire to shallowly repand; apex acute to acuminate; petioles (2–)4–5 cm, glabrous to densely pubescent with hairs like those of the young stems. Inflorescences 2.5–4.5 cm, extraaxillary, unbranched or branched, with 8–15 flowers, the plants strongly andromonoecious, with one to few hermaphroditic flower(s) at the base of the inflorescence and all other flowers functionally staminate, the axes densely stellate-pubescent with hairs like those of the stems, unarmed; peduncle 2–5 mm; rachis 2.3–4.2 cm; pedicels 10–15 mm in flower and fruit, densely congested, spaced 1–4 mm apart, articulated at base. Flowers 5-merous. Calyx ca. 4.5 mm long, the tube at anthesis 1.1–1.4 mm, the lobes ca. 2.5 × 2 mm, the apex truncate to broadly obtuse, the abaxial surface densely pubescent with short-stalked to sessile porrect-stellate hairs, unarmed; fruiting calyx tube becoming slightly inflated and knobby, the lobes 5–5.5 × 3–3.9 mm, slightly reflexed, subtending the fruit. Corolla 4.5–5 cm in diameter, 22–23 mm long, stellate to rotate-stellate, lobed for more than half of its length, membranaceous, violet to blue, the tube 6–7.5 mm, the lobes 11–14 × 3–3.5 mm, lanceolate, with moderate interpetalar tissue, sparsely pubescent adaxially with sessile porrect-stellate hairs, the rays 5–8, the midpoints often pronounced, ca. 0.1 mm long, densely pubescent abaxially along central portion of lobes with sessile porrect-stellate hairs. Stamens equal, the filament tube 0–0.1 mm, the free part of the filaments 1.5–1.8 mm, glabrous; anthers ca. 13 × 2.8 mm, tapered, not connivent, yellow, the pores directed distally, not opening into longitudinal slits with age. Ovary glabrous to sparsely pubescent with stalked glandular hairs; style in hermaphroditic flowers 14–15 × 0.2–0.5 mm, cylindrical, emergent from anther column, curved at apex, glabrous or sparsely pubescent in lower half with sessile stellate or short-stalked unbranched glandular hairs; style in staminate flowers 4–4.5 × ca. 0.2 mm, cylindrical, included within anther column, straight at apex, glabrous or sparsely pubescent in lower half with sessile stellate or short-stalked unbranched glandular hairs; stigma capitate, slightly bilobed. Fruit a berry, 1–1.9 cm in diameter, globose, apparently green and juicy at maturity, glabrous, the pericarp thin. Seeds 2.6–3 × ca. 2.5 mm, strongly flattened, reniform, orange to light brown, rugose.

Distribution and phenology.—Clearings and open places in disturbed, transitional and lowland tropical rainforest, 200–1100 m in elevation, mainly along the eastern Andean slopes in Ecuador, but extending into southern Colombia and northern Peru. Flowering specimens were collected in February-August and October-December. Fruiting specimens were collected in February, May, August-September and November-December.

Conservation status.—According to the IUCN Red List Categories (IUCN 2010), *S. cyathophorum* is clas-

FIG. 1. *Solanum cyathophorum* M. Nee & Farruggia. Image of isotype [D. Neill, W. Palacios & J. Zaruma 6506 (MO)].

sified as LC (Least Concern). Populations of this species are known from multiple locations throughout a broad range, and many of the collections are from protected areas.

Local names.—Ecuador: apumpu (Quichua, *Hurtado 2733*); apumpu yura (*Neill et al. 6506*); papa mandi (*Freire et al. 2175*); untukar (Shuar, *Shiki RBAE222*); bamba (*Mowbray 702102*); ttottopaje (Cofán, *Cerón 301*).

Uses.—*Cerón 301* reports that the bark is used to induce vomiting.

This is the species listed as "sp. nov. ined." in Nee (1999) under unnamed series 1 of *Solanum* section *Crinitum*. Within section *Crinitum*, *S. cyathophorum* most closely resembles *S. altissimum* Benítez and *S. kioniotrichum* Bitter ex J. F. Macbr. *Solanum altissimum* is distributed throughout the western Amazon Basin from Colombia and Venezuela to Peru and western Brazil. *Solanum kioniotrichum* is endemic to Departmento Loreto, Peru. All three species have small round glabrous fruits (1–2 cm) and predominantly entire leaves. *Solanum cyathophorum* differs from *S. altissimum* and *S. kioniotrichum* in having a calyx with truncate lobes that do not completely cover the corolla in bud, thus exposing the end of the corolla. In *S. altissimum* and *S. kioniotrichum* the calyx lobes are acute to obtuse and completely cover the corolla in bud, only splitting later to expose the corolla. The adaxial leaf surfaces of *S. cyathophorum* are either completely glabrous or sparsely pubescent with hairs having a multiseriate stalk and 1–2 horizontal apical ray cells. Specimens of *S. altissimum* have similiar hairs on the adaxial leaf surface, but may include hairs which are stellate or reduced to rounded knobs. *Solanum kioniotrichum* can be easily distinguished from both *S. altissimum* and *S. cyathophorum* by the pronounced basal cells of the adaxial leaf hairs. Evidence from nrDNA ITS sequence data and morphology suggests that *S. cyathophorum* is most closely related to *S. altissimum* (F.T. Farruggia & L. Bohs, unpublished data).

Etymology.—The name refers to the shape of the calyx: cyatho- (from the Greek "kyathodes"), meaning cuplike, and the suffix –phorum, meaning to bear or carry.

Additional specimens examined: **COLOMBIA. Putumayo:** Comisaría del Putumayo, márgenes del Río Putumayo entre la desembocadura del Güamués y Puerto Asís, 270 m, 21 Dec 1940, *J. Cuatrecasas 11245* (COL, F, US). **ECUADOR. Morona-Santiago:** Gualaquiza Cantón, Valle del Río Quimi, 1090 m, Dec 2000, *M. Cerna et al. 387* (BM, MO, NY); Cantón Tiwintza, Parroquia Santiago, road Santiago–Patuca, 3°01'14"S, 78°03'03"W, 350 m, 15 Aug 2005, *J.L. Clark 9311* (NY, US); bosque tropical húmedo de Amazonas Taisha, 2°23'S, 77°30'W, 500 m, 14–15 Oct 1975, *E. Little et al. 703* (QCNE, US); El Centro Shuar Kankaim, (Cangaimine), Río Kankaim (Cangaime), (20 km WNW del Taisha), 500 m, 15 Oct 1985, *D. Shiki RBAE222* (MO, NY). **Napo:** Aguarico, Reserva Étnica Huaorani, carretera y oleoducto de Maxus en construcción, km 61, al S del Río Tivacuno, 250 m, 26 Oct 1993, *M. Aulestia 1177* (NY); Cantón Lago Agrio, Duremo, Comunidad indígena Cofán, 350 m, 4 May 1986, *C. Cerón 301* (MO, NY); Lago Agrio, between Lago Agrio and Santa Cecilia, 28 Jul 1972, *J.D. Dwyer 10285* (MO, NY); Orellana, Parque Nacional Yasuní, carretera y oleoducto de Maxus en construcción, km 6–9, 250 m, 12 Dec 1993, *A. Grijalva 697* (BM, MO, NY); Misahualli, in the surroundings of the junction Río Misahualli–Río Napo, 500 m, 13 Aug 1979, *L.B. Holm-Nielsen et al. 19119* (AAU, MO, NY); Aguano, edge of the town Aguano (also Ahuano) on the Río Napo, 550 m, 14 Feb 1973, *J. Humbles 6204* (F, MO); Cantón Archidona, Huiruno, al pie del Volcán Sumaco, carretera Hollín–Loreto, 5 km al SW de Loreto, 450 m, 24 Nov 1989, *F. Hurtado 2733* (MO, NY); Lago Agrio, carretera hacia Río San Miguel, 11 Feb 1980, *J. Jaramillo & F. Coello 2227* (NY, QCA); Ahuano, at Río Napo, 25 Mar 1969, *H. Lugo S. 880* (GB, MO); Las Sachas, Las Sachas road Coca (Puerto Francisco de Orellana), Lago Agrio, 30–40 km NE of Coca, 13 Feb 1973, *H. Lugo S. 3395* (GB, MO); Guamanyacu, road Coca (Puerto Francisco de Orellana)–Lago Agrio, ca. 40 km NE of Coca, 18 Feb 1973, *H. Lugo S. 3396* (GB, MO); Santa Rosa de Quijos, road Lago Agrio–Baeza, 24–26 km NE of Baeza, 28 Feb 1973, *H. Lugo S. 3585* (GB, MO); Limoncocha, pasture N of runway, Feb 1970, *R.N. Mowbray 702102* (MO); Estación Experimental INIAP-Payamino, 5 km al N de Coca, 250 m, 9 Sep 1986, *D. Neill et al. 7341* (NY); km 42, carretera Lago Agrio–Coca, Plantación Experimental de Corp. Forestal Durini, 450 m, 21 Sep 1985, *W. A. Palacios et al. 815* (NY); Cantón Loreto, Vía Payamino–Loreto, Comunidad Jumandi, 350 m, Jul 1993, *W. A. Palacios 10953* (BM, F, NY); 15 km al W de Coca, costado S del Río Napo, por vía de Los Zorros, 0°35'S, 77°02'W, 250 m, 18–20 Apr 1985, *Zaruma et al. 114* (MO, NY, US). **Pastaza:** ca. 15 km N of Puyo along side road to the E, 1000 m, 27 Dec 1987, *B.M. Boom et al. 7831* (NY, QCA, US). **Sucumbíos:** Cascales Cantón, Parroquia El Dorado, Cooperative Los Angeles, Bloque 11 Compañía Santa Fe, 3 km entre La Troncal y Los Ángeles, 250 m, 3 May 1997, *E. Freire et al. 2175* (MO). **Zamora-Chinchipe:** El Pangui, Cordillera del Cóndor, valle del Río Quimi, 920 m, 10 Dec 2001, *L. Miranda 140* (NY). **PERU. Loreto:** Dtto. Tigre, Río Corriente, Shiviyacu, camino a Forestales (39 km), 25 Nov 1979, *F. Ayala 2315* (MO, NY); basin of Río Ucayali, vic. Jenaro Herrera, 4°55'S, 73°45'W, 13 Feb 1988, *D. Daly et al. 5643* (MO, NY); Río Javari, behind Angamo Garrison, 4 Aug 1973, *E. Lleras et al. P17133* (MO, NY, UFMT).

Solanum adenobasis M. Nee & Farruggia, sp. nov. (**Fig. 2**). Type: PERU. Dept. Amazonas: Bagua, near Puente Almendro I, km 296 of Marañón road (from Olmos junction), 5°15'S, 78°20'W, 620 m, 6 Jul 1984, *S.D. Knapp & J. Mallet 6565* (holotype: USM; isotypes: F, GH, NY).

Arbor, 3–10(–20) m × ca. 6–12 cm diametro, truncus aculeis crassis armatus, flores magnae, corollis 4–6(–8) cm diametro, rotato-stellatis, fructus globosus, glaber, 4–7 cm diametro. *Solano acanthodi* et *S. grandifloro* affinis sed pilis glanduliferis ad basim pilorum stellatorum caulium vestitis differt.

Tree 3–10(–20) m × ca. 6–12 cm dbh. Trunk with sharp, stout broad-based prickles, the bark light tan to dark brown, thin, the slash soft, white with yellow fibers; juvenile stems densely covered with stout broad-based prickles; flowering stems unarmed or with broad-based prickles, often densely pubescent with long multiseriate-stalked porrect-stellate hairs, the stalks 4–5 mm long, the base of the stalk with a tuft of small glandular hairs, the stellate apex 2–3 mm in diameter, the rays 3–6, the midpoint ca. 0.5 mm long. Sympodial units difoliate, geminate. Leaves simple, the blades 30–120 × 15–45 cm or more, ca. 2 times as long as wide, ovate to lanceolate, chartaceous, the fresh leaves dark green and somewhat shiny adaxially, lighter green to golden-tan abaxially, the adaxial surface moderately pubescent with multiseriate-stalked porrect-stellate hairs, the stalks 1–2.5 mm, the stellate apex 1–2 mm in diameter, the rays 2–4(–6), eglandular, the abaxial surface densely pubescent with golden-tan multiseriate-stalked porrect-stellate hairs, the stalks ca. 1 mm, the rays 5–6, the midpoint lacking; major veins 5–6 on either side of midvein; base cuneate to oblique; margin shallowly lobed to nearly entire, the lobes deltoid; apex acute to acuminate; petioles 6.5–9(–30) cm, moderately to densely pubescent with hairs like those of the young stems. Inflorescences 2.5–8 cm, extraaxillary, unbranched or once-branched, with 8–15 flowers, the plants strongly andromonoecious, with one to few hermaphoditic flower(s) in the inflorescence and all other flowers functionally staminate, the axes densely stellate-pubescent with hairs like those of the stems, unarmed; peduncle 0.5–3 cm; rachis 2–7.5 cm; pedicels 5–17 mm in flower and fruit, densely congested, spaced 1–4 mm apart, articulated at base. Flowers 5-merous. Calyx 12–15 mm long, the tube at anthesis 1.1–2 mm, the lobes 11–14 × 2.5–3 mm, the apex acute to acuminate and thick, the abaxial surface densely pubescent with long-stalked porrect-stellate hairs, the stalks 2–3 mm with glandular hairs present at base, unarmed; fruiting calyx tube becoming strongly inflated and knobby, the lobes 10–35 × 8–18 mm, subtending the fruit. Corolla 4–6(–8) cm in diameter, rotate-stellate, lobed for more than half its length, membranaceous, violet fading to white, the tube 20–23(–28) mm, the lobes 29–36(–39) × 6–7 mm, deltate, with abundant interpetalar tissue, the adaxial surface glabrous or with sparse sessile to short-stalked stellate to multangulate hairs along midvein near apex, the abaxial surface densely covered along lobes with sessile porrect-stellate hairs. Stamens equal, the filament tube 0–0.1 mm, the free part of the filaments 1.7–2 mm, glabrous; the anthers 11–14 × 1.8–2.1 mm, tapered, connivent, yellow, the pores directed distally. Ovary glabrous; style in hermaphoditic flowers 12–15 × 0.5–0.8 mm, cylindrical, emergent from anther column, curved at apex, sparsely pubescent at base with short glandular hairs; style in staminate flowers 2–3.2 × ca. 0.2 mm, cylindrical, included within anther column, straight at apex, sparsely pubescent at base with short glandular hairs; stigma short-cylindrical to capitate. Fruit a berry, 4–7 cm in diameter, globose, green and juicy at maturity, glabrous and lustrous, the pericarp thin. Seeds 2.5–3.5 × 2.5–3 mm, strongly flattened, reniform, orange to light brown, rugose.

Distribution and phenology.—Clearings and open places in disturbed, lowland to upland tropical rainforest, 180–1200(–1600) m in elevation, mainly along the eastern Andean slopes in southern Ecuador and northern Peru. Flowering specimens were collected March-December. Fruiting specimens were collected May-December.

Conservation status.—According to the IUCN Red List Categories (IUCN 2010), *S. adenobasis* is classified as VU-B1a+biii; A2c; D1 (Vulnerable). Populations of this species are located near expanding population centers leading to highly fragmented populations. The extent of occupancy is estimated to be less than 25,000 km^2, and there are estimated to be less than 1,000 mature individuals across its range. There is also a continuing decline in suitable habitat in these regions due to deforestation and the establishment of new settlements.

Local names.—Ecuador: pungalá (*Narváez 446*); untukar (Shuar, *Kunkumas RBAE184*). Peru: untukag (*Ancuash 460*).

Uses.—Used as a graft with the edible-fruited naranjilla, *Solanum quitoense* Lam. (*Narváez 446*). According to *Kunkumas RBAE184* the fruit is not edible.

Fig. 2. ***Solanum adenobasis*** **M. Nee & Farruggia. A. Habit. B. Juvenile stem with stout recurved prickles. C. Flowering branch showing rotate staminate flower and stellate hairs with glandular bases. D. Fruit with prominent swollen calyx. Drawn from photos of *L. Bohs et al. 3808* & *3833* (UT).**

This species was alluded to as one of the unnamed species of Series 4 of sect. *Crinitum* by Nee (1999), all of which are characterized by shiny, glabrous, smooth-walled fruits about 4–7 cm in diameter. Within *Solanum* section *Crinitum*, *S. adenobasis* most closely resembles *S. acanthodes* Hook.f. and *S. grandiflorum* Ruiz & Pav. The distribution of these three taxa overlaps in Peru and Ecuador; however, *S. grandiflorum* is more widespread throughout the Andes and *S. acanthodes* is distributed throughout the western Amazon Basin, while *S. adenobasis* is restricted to northern Peru and southern Ecuador. All three species have large (4–7 cm) round glabrous fruits, more or less spiny trunks, and predominantly shallowly lobed leaves. *Solanum adenobasis* differs from *S. acanthodes* and *S. grandiflorum* in having tiny but prominent glandular hairs at the base of the long-stalked stellate hairs found on the stem and adaxial surface of the petiole. In *S. grandiflorum* and *S. acanthodes* the stems and petioles often lack long-stalked stellate hairs, but when present the stalk lack glandular hairs at the base. Furthermore, *S. grandiflorum* has a closely appressed tan stellate tomentum covering most surfaces including the calyx, while both *S. adenobasis* and *S. acanthodes* have a calyx that is covered with long-stalked stellate hairs well-separated from one another, leaving the calyx surface visible.

Etymology.—The name refers to the glandular (aden- from Greek) base (basis- from Greek) of the long-stalked stellate hairs.

Additional specimens examined: **ECUADOR. Morona-Santiago:** La Misión Salesiano, 5 km al S del Río Bomboiza y cerca la carretera Zamora–Gualaquiza, orilla del Río Bomboiza, 800 m, 23 Aug 1985, *M.A. Baker 6283* (MO, NY); 10 km W del Río Zamora y 2 km al S del Río Bomboiza, alrededores de la Misión Salesiano, 3°27'S, 78°32'W, 800 m, 14 Mar 1986, *M.A. Baker 6737* (MO, NY); Centro Shuar Yukutais, S of Centro, 950 m, 5 Nov 1988, *B.C. Bennett & P. Gómez 3526* (NY); Centro Shuar Yukutais, 3°30'S, 78°10'W, 31 Mar 1989, *B. Bennett et al. 3630* (NY, QCNE); Cantón Gualaquiza, carretera Zamora–Gualaquiza, 1000–1500 m, 21 Jun 1991, *E. Gudiño et al. 1431* (NY); ca. 32.5 km S of Gualaquiza (ca. 91 km N of Zamora) on road to Zamora, 3°35'S, 78°3'W, 850 m, 4 Feb 1984, *S.D. Knapp & J. Mallet 6243* (NY, US); along Méndez–Sucúa road, 2°38'S, 78°13'W, 600 m, 11 Jun 1979, *B. Løjtnant 14557* (NY); Parroquia Gualaquiza, km 2 al sur de Gualaquiza, 3°25'S, 78°36'W, 1000 m, 20 Oct 1999, *E. Narváez & H. Clark 446* (NY); Río Cuyes, entre Gualaquiza y Bomboiza, 3°25'S, 78°35'W, 800 m, 1 Nov 1986, *D. Neill et al. 7385* (MO, NY). **Zamora-Chinchipe:** road between El Pangui and Montery departing main Zamora–Gualaquiza Road, 8.5 km N of El Pangui, 11.8 km from main highway, 2 km E of La Argelia, 10.3 km W of Guisne, 950 m, 25 May 2003, *T.B. Croat & M. Menke 89341* (NY); carretera Zamora–Gualaquiza, San Roque, camino a La Delicia, 145 km de Loja Potrero, 950 m, 11 May 1996, *V. Van der Eynden 753* (NY). **PERU. Amazonas:** Condorcanqui, Quebrada chichijam entsa, Río Cenepa, 402 m, 24 May 1973, *E. Ancuash 460* (F, MO, NY); Condorcanqui, N of Río Cenepa, E of Quebrada Icakita, 800 m, Oct 1972, *B. Berlin 268* (BM, MO, NY); Condorcanqui, confluence of Icikiti & Cenepa, 244 m, 18 Dec 1972, *B. Berlin 627* (F, NY); Bagua, road between Bagua Chica & Imacita, between El Moyo and Chiriaco, 5°17'39"S, 78°24'45"W, 420 m, 30 May 2010, *L. Bohs et al. 3808* (UT); Condorcanqui, Río Cenepa region, Quebrada Huampami, Río Cenepa, Monte, 182 m, May 1973, *R. Kayap 820* (F); Condorcanqui, Río Cenepa, vic. of Huampami, ca. 5 km E of Chávez Valdívia, al lado de chacra de Pedro, 200 m, 14 Aug 1978, *A. Kujikat 323* (MO, NY); Condorcanqui, valle del Río Santiago, Quebrada Caterpiza, 2–3 km atrás de la comunidad de Caterpiza, 180 m, 17 Mar 1980, *S. Tunqui 1035* (MO, NY); Condorcanqui, Distrito El Cenepa, comunidad de Tutino, 340 m, 28 Jul 1997, *R. Vásquez et al. 24441* (BM, MO, NY, USM). **Cajamarca:** Huarango, El Convento, 5°13'S, 78°40'W, 1200–1600 m, 1 Jul 1996, *J. Campos & E. Rodríguez 2837* (NY, USM). **Loreto:** Maynas, Distrito Iquitos, Puerto Almendra (UNAP), 18 Sep 1972, *B. Berlin 71* (BM, MO, NY). **San Martín:** Rioja, Segunda Jerusalén, ca. 15 km NW of Rioja on main road between Rioja & Pedro Ruiz, 5°58'34"S, 77°17'23"W, 820 m, 1 Jun 2010, *L. Bohs et al. 3833* (UT); San Martín, 7–15 km E of Shapaja on the road to Chazuta, 400 m, 15 May 1986, *S.D. Knapp et al. 7272* (F, MO, NY); Rioja, town of Naranjillo, 5°48'21"S, 77°23'54"W, 910 m, 14 Dec 2007, *S. Stern et al. 156* (NY, USM, UT).

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REFERENCES

Bohs, L. 2005. Major clades in *Solanum* based on *ndh*F sequence data. In: Keating, R.C., V.C. Hollowell, and T.B. Croat, eds. A festschrift for William G. D'Arcy: the legacy of a taxonomist. Monogr. Syst. Bot. Missouri Bot. Gard. 104. Missouri Botanical Garden Press, St. Louis, Missouri. Pp. 27–49.

IUCN Standards and Petitions Subcommittee. 2010. Guidelines for using the IUCN Red List categories and criteria. Version 8.0. Prepared by the Standards and Petitions Subcommittee in March 2010. Downloadable from http://intranet.iucn.org/webfiles/doc/SSC/RedList/RedListGuidelines.pdf.

Levin, R.A., N.R. Myers, and L. Bohs. 2006. Phylogenetic relationships among the "spiny solanums" (*Solanum* subgenus *Leptostemonum*). Amer. J. Bot. 93:157–169.

Linnaeus, C. 1753. Species plantarum. Stockholm.

Nee, M. 1999. Synopsis of *Solanum* in the New World. In: Nee, M., D.E. Symon, R.N. Lester and J.P. Jessop, eds. Solanaceae IV: Advances in biology and utilization. Royal Botanic Gardens, Kew. Pp. 285–333.

Whalen, M.D. 1984. Conspectus of species groups in *Solanum* subgenus *Leptostemonum*. Gentes Herb. 12: 179–282.

A NEW SPECIES OF *CAMPOMANESIA* (MYRTACEAE) FROM BAHIA, BRAZIL, BASED ON SPECIMENS COLLECTED BY J.S. BLANCHET OVER 150 YEARS AGO

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ABSTRACT

A new species of *Campomanesia* Ruiz et Pav., collected by Blanchet in Bahia, Brazil, is here recognized. A description, discussion, images of collections and a key comparing **Campomanesia blanchetiana** Landrum & Ibrahim with two similar species, *C. eugenioides* (Cambess.) Legrand and *C. espiritosantensis* Landrum, are provided.

RESUMO

Uma nova espécie de *Campomanesia* Ruiz et Pav., coletada por Blanchet no estado da Bahia, Nordeste do Brasil, é reconhecida neste trabalho. São apresentadas descrição, discussão, fotografias e uma chave de identificação para comparar **Campomanesia blanchetiana** Landrum & Ibrahim com duas espécies semelhantes, *C. eugenioides* (Cambess.) Legrand e *C. espiritosantensis* Landrum.

KEY WORDS: Taxonomy, Moricand, Nazaré das Farinhas, old herbarium specimens

Jacques Samuel Blanchet, Swiss ambassador in Bahia, Brazil, from 1828 to 1856 and an early plant collector in that country (Staflue & Cowan 1976), has provided numerous type specimens, as can be deduced by searching the epithets containing "blanchet" in the International Plant Name Index (http://www.ipni.org/ipni/ plantnamesearchpage.do). Some genera are named in his honor, for instance *Blanchetia* DC. (Asteraceae) (Stafleu & Cowan 1976). Most of these taxa were recognized as new in the 19th Century, but some are still being discovered based on Blanchet collections. For example, Landrum and Funch (2008) recently described *Psidium bahianum* with a Blanchet collection cited as a paratype. The present new species is known to us by only four sheets, one each at F and NY, and two at G, all distributed as Blanchet collections and possibly all originally held at the Moricand Herbarium. This herbarium of ca. 50,000 specimens was amassed in the early 19th century by Moise-Etienne Moricand, a botanical associate of A. P. de Candolle (Stafleu & Cowan 1981). The two G specimens have labels indicating that they were donated in 1908 by the grandson of Moricand.

Specimens of our new species have been filed as *Psidium* indet. and under "*P. aggregatum*," a nomen nudum, and *Myrtus blanchetiana* O. Berg (=*P. salutare* var. *salutare*; Landrum 2003) for perhaps more than 100 years. To even the trained eye, they would appear to be *Psidium*, but when an ovary was dissected, the 8–10-locular ovary, with 7–10 ovules per locule, clearly placed the specimens in *Campomanesia* (Fig. 2D). Flowering specimens of *Psidium* and *Campomanesia* are superficially very similar and many species of *Campomanesia* were originally described as *Psidium*. Fruit and seed characters separate the genera as well (Landrum and Sharp 1989), but are not available for this new species.

The packet of the NY specimen contains a hand written note in Latin comparing the plant with species of *Psidium* L. (some of which are now placed in *Campomanesia* Ruiz et Pav.) and *Myrtus* L. (one of which is now placed in *Calycolpus* O. Berg). No species or genera of O. Berg are mentioned, so it is likely that the note was written before the work of Berg on Brazilian Myrtaceae (1855–1859). Apparently Berg never saw any of the sheets, as he doubtless would have described them as new. On one of the sheets from G there is a label (in the same hand writing as the note at NY) identifying the locality of collection as Nazareth [Nazaré] das Farinhas and the collector as "M. Blanchet." Presumably, the note was not written by Blanchet, but could have been written by Moricand.

Blanchet and "Nazaré das Farinhas." The collections attributed to Blanchet in Bahia extend from Jacobina and Rio de Contas in the interior of Bahia to the coast (Urban 1840–1857). However, many of his collections were made by others, and some Blanchet localities have still not been confirmed. More confidence can be placed in localities near the coast (A.M. Giulietti, pers. comm.). As indicated on one label, *Campomanesia blanchetiana* was presumably collected at "Nazaré das Farinhas" (commonly appearing on maps simply as Nazaré). Nazaré is a center for the production of "mandioca" (*Manihot esculenta* Crantz., Euphorbiaceae) from which the food product "farinha" is produced, which accounts the town's name. Since the time of Blanchet this area, not far from Salvador, has been drastically altered by urbanization and the cultivation of plantations of oil palm or "dendê" (*Elaeais guineensis* Jaquim, Arecaceae). Since our new species has not been recollected in over 150 years the chances that it is now extinct are regrettably high.

Campomanesia blanchetiana Landrum & Ibrahim, sp. nov. (**Figs. 1, 2**). TYPE: BRAZIL. BAHIA: (fl) *J.S. Blanchet 1611* (HOLOTYPE: G!; ISOTYPE: F!).

Campomanesiae eugenioidii (Cambessedes) Legrand primo adspectu simillima, sed calyce ante anthesin subclauso, sub anthesi inter lobos fissus, et venis lateralibus rectis, ca. 12-binatis differt.

Tree or shrub, glabrous except for minute hairs on some young growth (especially terminal buds), and inner surface of calyx-lobes; hairs light reddish brown to whitish, less than 0.1 mm long; young twigs drying reddish brown, the bark of older twigs light brown to yellowish, remaining smooth or somewhat flaky and cracked; leaves elliptic to lanceolate, 3–10 cm long, 1.2–4.2 cm wide, 2.4–3.5 times as long as wide; apex acuminate; base cuneate to acuminate; petiole 2–4 mm long, 0.5–1 mm wide, channeled; midvein impressed above, raised prominently below; venation brochidodromous with ca. 12 lateral veins, these nearly straight, leaving the midvein at an angle of more than 45 degrees, connecting to an arching lateral vein that follows the margin, mostly within 1–2 mm of the margin; secondary veins dendritic, alternating with the laterals and seeming to arise mainly from the marginal; blades subcoriaceous, drying reddish brown to yellowish brown, densely glandular below. Flower buds broadly pyriform, to ca. 8 mm long, glabrous to minutely puberulent, the base attenuate; peduncles 10–20 mm long, 0.6–1 mm wide, glabrous to puberulent, often superimposed in pairs; bracteoles linear, caduceus before anthesis, ca. 1 mm long, ca. 0.2 mm wide; calyx nearly closed in young bud, the terminal pore gradually expanding as the bud matures, with lobes reduced to undulations along the margin, at anthesis tearing more or less regularly into 5 lobes, these broadly truncate, ca. 1.5 mm long by 3–4 mm wide, the tears not entering the staminal ring; petals suborbicular to obovate, 7–8 mm long, glandular without; hypanthium infundibular, puberulent to glabrous, densely glandular; disk (including staminal ring) ca. 5 mm across in recently opened flowers, glabrous; stamens ca. 10 mm long, ca. 325; anthers ca. 0.5 mm long; style ca. 4.5 mm long, with a swollen base; ovary 8–10-locular; ovules 7–11; fruit unknown.

Additional specimens examined. **BRAZIL. Bahia:** "Nazareth [Nazaré] das Farinhas," *Blanchet 322* (G); "circa Bahia," *Blanchet 604* (NY).

We believe that it is possible that all these Blanchet collections may be one gathering as they are all quite similar, but since they have different numbers we cite them as separate collections. Although *Blanchet* 322 and *604* are technically paratypes, we believe that they should be preserved with the same care as isotypes.

Campomanesia blanchetiana is most similar to *C. eugenioides* and we compare the two in the key below.

1. Calyx open in young flower bud, with lobes triangular, ovate, oblong, or hemiorbicular, 1–3 mm long and wide, without tears forming between the lobes as the bud opens; lateral veins ca. 4–7 pairs, curving toward apex; leaves mainly less than 2.5 times as long as wide; stamens up to ca. 200 ____ **C. eugenioides**
1. Calyx nearly closed in young flower bud, with a terminal pore that gradually expands as the bud matures, with the lobes reduced to undulations along the margin in the closed bud, at anthesis tearing more or less regularly into 5 lobes, these broadly truncate, ca. 1.5 mm long by 3–4 mm wide; lateral veins ca. 12 pairs, nearly straight; leaves mainly more than 2.5 times as long as wide; stamens ca. 325 ____ **C. blanchetiana**

Another similar species is *Campomanesia espiritosantensis* Landrum, known only from two collections from Reserva Florestal do Rio Doce in Espirito Santo. The two species are compared in the key below.

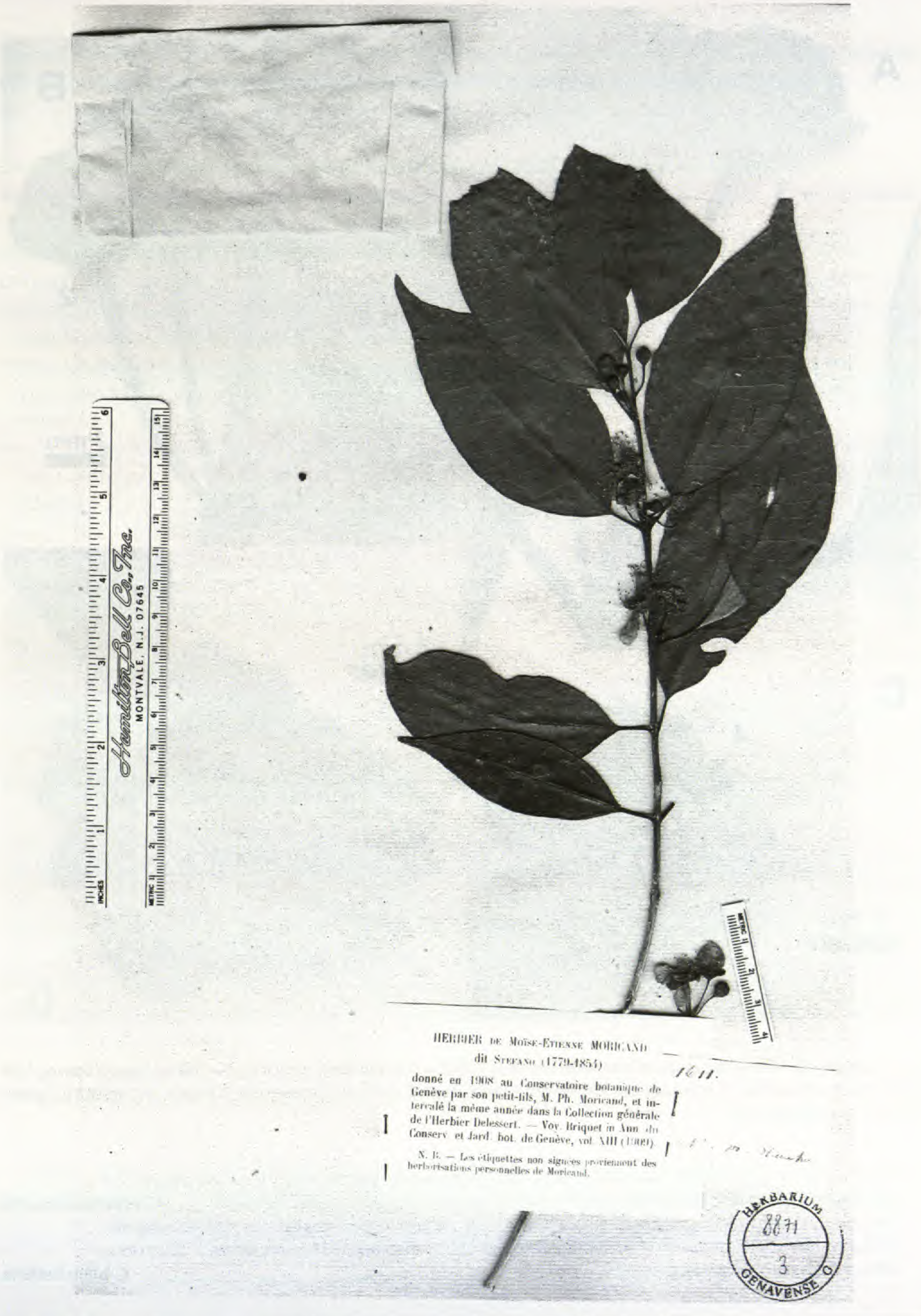

Fig. 1. Holotype of *Campomanesia blanchetiana*, *Blanchet 1611* at G.

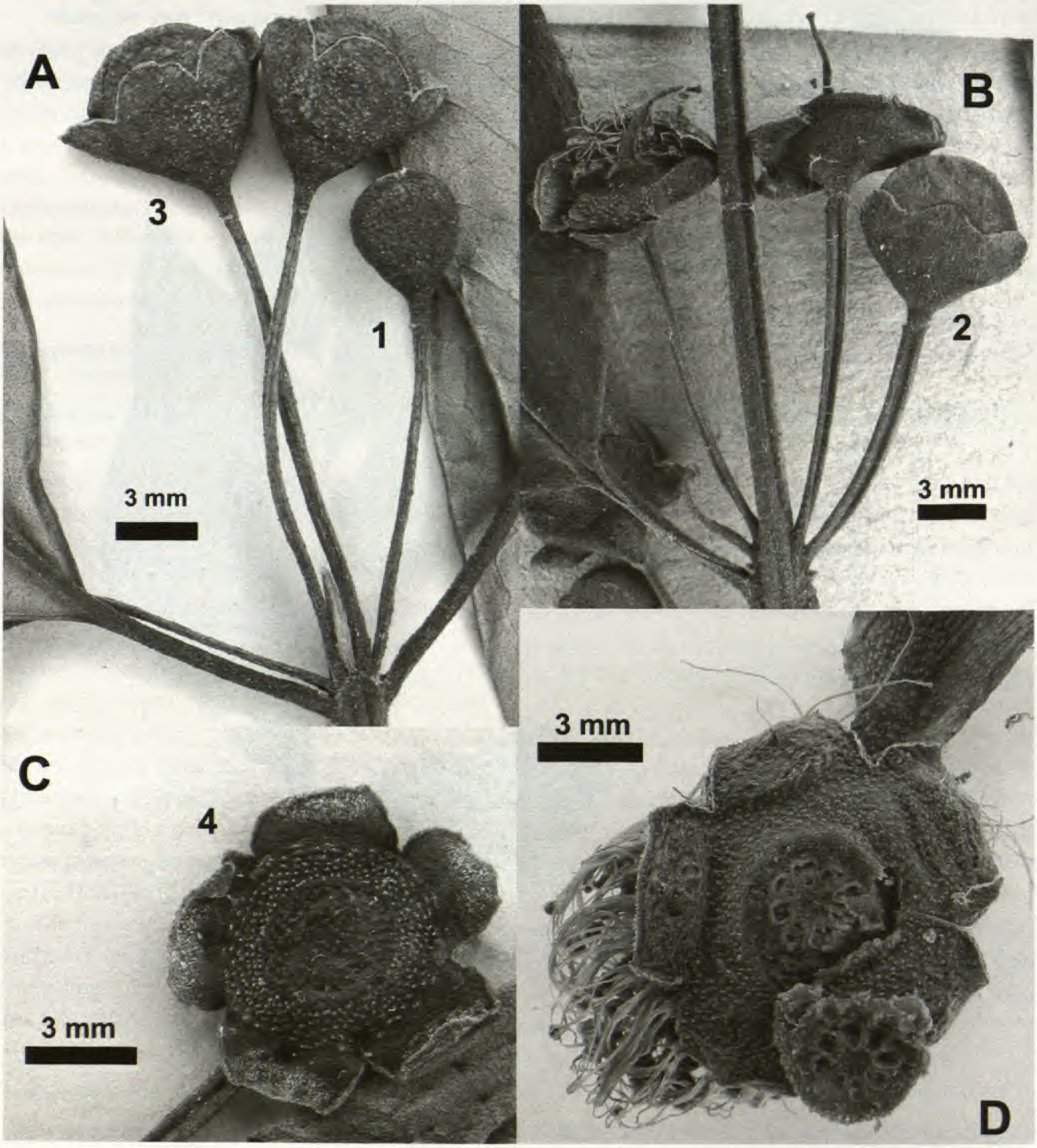

Fig. 2. *Campomanesia blanchetiana*, images of buds and flowers. A, B, C, flowers at various stages of anthesis; 1–4 indicate stages of opening, from nearly closed to after anthesis. D, cross-section of ovary showing 8 locules, a typical number for *Campomanesia*. A, *Blanchet 1611* at F; B & D, *Blanchet 322* at G; C, *Blanchet 604*. at NY.

1. Calyx closed in the bud, with an apiculate apex, at anthesis tearing irregularly; peduncles solitary; leaves 2–7 cm long, commonly with pocket-like folds of tissue on the lower surface (possible domatia) _____ **C. espiritosantensis**
1. Calyx nearly closed in young bud, with a terminal pore that gradually expands as the bud matures, at anthesis tearing more or less regularly into 5 lobes; peduncles often superimposed in pairs; leaves 3–10 cm long without folds of tissue on lower surface. _____ **C. blanchetiana**

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REFERENCES

Berg, O. 1855–1856. Revisio Myrtacearum Americae. Linnaea 27:1–472.

Berg, O. 1857–1859. Myrtaceae. In: C.F.P. Martius, A. Eichler, and I. Urban, eds. Flora Brasiliensis. F. Fleisher, Lipsae. 14(1):1–655.

Landrum, L.R. 2003. A revision of the *Psidium salutare* complex (Myrtaceae). Sida 20:1449–1469.

Landrum, L.R. and L.S. Funch. 2008. Two new species of *Psidium* (Myrtaceae) from Bahia, Brazil. Novon 18:74–77.

Landrum, L.R. and W.P. Sharp. 1989. Seed coat characters of some American Myrtinae (Myrtaceae): *Psidium* and related genera. Syst. Bot. 14:370–376.

Stafleu, F.A. and R.S. Cowan. 1976. Taxonomic literature: a selective guide to botanical publications and collections with dates, commentaries and types, v.1, 2nd. ed. International Association for Plant Taxonomy (IAPT), Utrecht.

Stafleu, F.A. and R.S. Cowan. 1981. Taxonomic literature: a selective guide to botanical publications and collections with dates, commentaries and types, v.3, 2nd. ed. International Association for Plant Taxonomy (IAPT), Utrecht.

Urban, I. 1840–1857. Vitae itineraque collectorum botanicorum. In: C.F.P. Martius, A. Eichler and I. Urban, eds. Flora Brasiliensis. F. Fleisher, Lipsae. 1(1):7.

BOOK REVIEW

D. Jesse Wagstaff. 2008. **International Poisonous Plant List: An Evidence-Based Reference.** (ISBN 978-1-420-06252-6, hbk.). CRC Press, Taylor and Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, Florida 33487-2742, U.S.A. (**Orders:** orders@taylorandfrancis.com, 1-800-272-7737, 1-800-374-3401 fax). $149.95, 464 pp., 8 ¾" × 11 ¼".

Appropriately, the glossy cover of this book sports a photo of bright, red aril-wrapped cones of *Taxus* (yew) at the end of a branch. Perhaps it's to hint that poisonous plants can be double-edged swords, serving as life-saving drugs, yet capable of harm. Such is the case for the poisonous alkaloids in *Taxus* that hold hope for cancer patients. Once in the book, the author sets out his objectives. Two of his objectives for the book are indicated in the title. First, he wanted the book to be international in use. To this end, he created a checklist that is alphabetical by genus, and to the extent possible, used accepted scientific names, including the plant name author. And to my delight, he lauded the importance of a codified taxonomy in the field of toxicology. Secondly, he wanted inclusion of a plant in the book to be based on primary sources, hence "An Evidenced-Based Reference" is part of the title. He alludes to the fact that the field of poisonous plants is most susceptible to erroneous reporting and repeated passing on of such information. Each plant entry, therefore, has anywhere from one to 20 or more citations for each species of plant. The third objective was to cross reference each entry with common names and synonyms, thus increasing the utility of the book. The book is, no doubt, a must-have reference for toxicologists, researchers, poison control centers, trade officials, physicians, and veterinarians.—*Robert J George, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76106-4025, U.S.A.*

FOLIA TAXONOMICA 18. THE STATUS OF *PASSIFLORA CITRIFOLIA* AND A NEW SPECIES IN SUBGENUS *ASTROPHEA* (PASSIFLORACEAE), *PASSIFLORA JUSSIEUI*

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ABSTRACT

It is shown that *Passiflora citrifolia* (Juss.) Mast. is illegitimate and that the historical collections are inadequate to establish a species. **Passiflora jussieui** is described from the Guianas for the species to which the name is applied since Killip's revision in 1938.

RÉSUMÉ

On montre que *Passiflora citrifolia* (Juss.) Mast. est illégitime et que les collections anciennes sont inadéquates pour définir une espèce. **Passiflora jussieui** est décrite des Guyanes pour l'espèce ainsi nommée depuis la révision de Killip en 1938.

INTRODUCTION

Nomenclatural history of *Passiflora citrifolia*

The nomenclature for *Passiflora citrifolia* (Juss.) Mast., a species of subgenus *Astrophea* (DC.) Mast., has evolved over the past 200 years. When Antoine Laurent de Jussieu (1805b, p. 392) described it in *Tacsonia* Juss. (1789), he said that if this species were accepted, one could name it *T. citrifolia*[1]. He did not accept that name, but merely proposed it for a future hypothetical naming whenever adequate material could be studied. Jussieu (1805b) said about the material (*herb. Richard*) he studied that it was impossible to establish a good species on such a specimen[2]. He stated that it was different from *P. glandulosa* Cav. and described *T. citrifolia* as follows. It has oval entire leaves smooth and coriaceous, 13.5 × 8 cm ("5 × 3 pouces") long, petioles 5.4 cm long with 2 glands at the apex, not at the base. The peduncle and therefore the bracts are missing. A detached flower has a tube nearly 4 cm long, a perianth divided in 10 oval lobes, a corona outer row made of filaments a few lineae long (1 linea = 2.255 mm) [misspelled as "ligues" for lignes], another inner row very small that seems to be made of glands. In the herbarium of the Museum d'Histoire naturelle in Paris (P), there is a specimen clearly belonging to this species for the leaves, but with only small flower buds, partly eaten by insects, in a pocket.

Augustin Pyrame de Candolle (1828, p. 335) validated the species by accepting it as *T. citrifolia* Juss., and the authorship should be given as Juss. ex DC. De Candolle placed *Tacsonia citrifolia* in *Tacsonia* section *Distephana* DC. close to *T. glandulosa* (Cav.) Juss. and added that the leaves were oval, coriaceous, entire, pinnately veined, and the petioles 2-glandular at apex "*v. s. in h. Juss.*" (= I have seen a dried specimen in the Jussieu herbarium) without detail about the specimen. There is no material of *P. citrifolia* in the Jussieu herbarium at P. Most likely de Candolle referred to the same material seen by Jussieu in 1805, and the description by de Candolle is shorter but agrees with Jussieu's text.

Max Joseph Roemer (1846, p. 199) did not cite any specimen. He raised section *Distephana* to the rank of genus and kept in the species that were in de Candolle's section. For *D. citrifolia* (Juss. ex DC.) M. Roem., he merely cited Jussieu and de Candolle, but the different brackets of the key leading to it could be patched together into a description: leaves unlobed, entire, coriaceous, glabrous, acute(?), oval; petioles 2-glandular

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[1] "Si elle etoit admise, on pourroit la nommer *T. citrifolia*."

[2] "Il e st impossible d'etablir sur un pareil individu une espece solide."

J. Bot. Res. Inst. Texas 4(2): 609 – 614. 2010

at base; bracts 2-glandular at base, remote from the flowers. Contrary to the material studied by Jussieu, the petiolar glands are basal versus apical and the bracts had basal glands when they were missing in the specimen known to Jussieu, both points on which Jussieu (1805b) insisted. It strongly suggests that the description was based on material representing *P. glandulosa* Cav.—his *D. glandulosa* (Cav.) M. Roem.

Maxwell Tyndell Masters (1871: 629) transferred the name to *Passiflora* L., unaware of, or dismissing, *P. citrifolia* Salisb. (1796). Richard Anthony Salisbury's species is illegitimate because the original publication included *P. alata* Curtis 1788, a valid name, as a synonym (McNeill et al. 2006; ICBN art. 53.1). Nevertheless, *P. citrifolia* Salisb. (1796) has priority over *P. citrifolia* (Juss. ex DC.) Mast. (1871), which therefore is illegitimate as a later homonym (McNeill et al. 2006; ICBN art. 45.3). Later mentions of *P. citrifolia* do not refer to Salisbury's name. Masters placed *P. citrifolia* (illeg.) in subg. *Astrophea* in his unnamed section 1 described as: inflorescences cymose-paniculate, trees or shrubs often without tendrils. He cited "Sagot, 1287 &c." as a specimen.

Ellsworth Paine Killip (1938: 541) gave a good description of *P. citrifolia* and cited three specimens from G, K, and P, all mentioned for the first time and collected later than 1805. He added: "none of these specimens have good flowers," but added that his description of the corona was based on "*Sagot* in 1857 (K)". In Paris (P) there is two sheets clearly labeled *Sagot Oct. 1857* and in a thin folder there are two other Sagot specimens, both with the mention "Herbier du Dr Sagot" and saying that it had been given by his widow in 1888; only one labeled *Sagot N° 1287*. Those specimens belong to the same species as the *herb. Richard* collection. In Killip, the description of the leaves agrees with previous ones, except the one by Roemer. Killip's description is in conflict with Jussieu on the description of the flower with a shorter tube and a corona with 4–5 rows versus 2. There is doubt that the specimens Killip did study were of the same biological taxon as the specimens examined by Jussieu and de Candolle, but they represent the species currently known from the Guianas as *P. citrifolia*.

Different concepts of *Passiflora citrifolia*

The material seen by Jussieu was never cited clearly and had a flower in a bad condition according to Jussieu (1805b) himself. In 1828, and de Candolle (1828) accepted Jussieu's provisional name as a good species and probably saw the same specimen. The collection used for the description apparently not seen since de Candolle and the species designated by this name are not clear described the species currently called *P. citrifolia*.

Roemer (1846) studied different material and has a concept in conflict with Jussieu's description. He probably saw a small variation in what is now called *P. glandulosa* in subg. *Passiflora* supersect. *Distephana* (DC.) Feuillet & J.M. MacDougal.

Masters (1871) did not give a description for the species and transferred it to *Passiflora*. Nevertheless, through its placement in subg. *Astrophea* and the specimen cited, it is clear that the concept he had of the species is different from the description of Roemer, but in agreement with Jussieu and de Candolle. Killip (1938) described the flower from what is probably the same material and confirmed the placement in subg. *Astrophea*.

The identity of the taxon described by Jussieu and accepted by de Candolle is uncertain due to the poor quality of the potential type collection. A troubling fact is that Jussieu, de Candolle, and Roemer fail to mention a clear character of the species currently known as *P. citrifolia*—the leaves have a dark marginal band when dried, an uncommon character in *Passiflora*. The modern concept of *P. citrifolia* does not match Roemer's description. Furthermore, it is not certain that the modern concept matches Jussieu's comments either. For those reasons, it seems better to describe the well documented species as a new species rather than merely give it a new name.

Because the name *Passiflora citrifolia* (Juss. ex DC.) Mast. is a later homonym, a other name is needed. In the absence of synonym and in order to have for type a good blooming specimen, it seems better to describe the well documented species as a new species rather than merely give it a new name.

TAXONOMIC TREATMENT

Passiflora jussieui Feuillet, sp. nov. (**Fig. 1**). TYPE: FRENCH GUIANA: Piste de Saint-Élie, 1 km from road Cayenne – Saint-Laurent-du-Maroni (RN 1), 53°00'W, 5°22'N, 7 Sep 2001, fl, *M.-F. Prévost & D. Barthélémy 4212* (HOLOTYPE US; ISOTYPE CAY).

? = *Tacsonia citrifolia* Juss. ex DC., Prodr. 3:335. 1828. Not *Distephana citrifolia* (Juss. ex DC.) M. Roem., Fam. Nat. Syn. 2:199. 1846.
= *Passiflora citrifolia* (Juss. ex DC.) sensu Mast., Trans. Linn. Soc. 27:629.1871; nom. illeg., non *P. citrifolia* Salisb. 1796.

Haec ad subgenero *Astrophea* sect. *Capreolatae* pertinens. Ad aliis speciebus, laminis foliorum cum margine subtus atrofasciato, floribus axillaribus solitarii vel in cauliflora inflorescentia aggregatis, perianthio albo, sepalis extra virellis violaceostriatis, coronae filamentibus 4–5-seriatis, extima serie explanata flava sed ad medium dense violaceomaculata, seriebus 2 et 3 erectis flavis violaceomaculatis, intima serie intime reflexa alba, fructibus angusto-fusiformibus 6-angularibus differt.

Scandent shrub when young, then liana, glabrous throughout except the ovary; trunk woody, up to 3cm diam., young stems terete, striate; stipules narrowly linear, soon deciduous. Leaves alternate; petioles dark red, 1.5–4.5 cm long, adaxially 2-glandular at apex, the glands sessile, swollen, becoming saucer-shaped when dry, yellow, when in growth, the young petiole oblique upward and the blade oblique downward displaying the yellow glands as a crude egg mimic-structure; blades coriaceous, oblong or ovate-oblong, 12–20 × 5–12 cm, shortly acute and truncate or rounded at base, abruptly short-acuminate at apex, margin entire, when dry there is abaxially a conspicuous marginal band, slightly recurved, narrow, dark brown or blackish when dried, venation pinnate, main lateral veins 4–7(–9) each side of the midrib, strongly arcuate toward the margin, prominently reticulate, when fresh pale green becoming dark with age, paler green abaxially. Flowers solitary and axillary on young stems or in cauliflorous racemes with undeveloped leaves, racemes often short, 1–5 cm long, sometimes as long as 50 cm, peduncles 4–6 mm long, bracts scale-like, glandless, early deciduous. Flower tube cylindric, 1.5–2 cm long, white to green, often heavily marked with brownish red; sepals 5, lingulate, about 3 × 1 cm, spreading and often recurved along the tube, outside colored like the tube, inside white; petals similar to the sepals in shape and habit, white; corona filaments in 4–5 series, the outermost subdolabriform, spreading, 18 mm long, yellow-green, heavily marked with dark red except at base and bright yellow apex, those of the next 2–3 series successively shorter, 1/3 to 1/6 as long, thick, oblique to erect, colored like the first row, the innermost 1–2 mm long, filiform, some slightly capitate, reflexed into the tube, white; operculum borne halfway up in the floral tube, slightly exerted, tubular, membranous at base, laciniate at apex, white, light purple at apex; androgynophore 3–3.6 cm long, white to green; stamens 5, filament flattened, fused at base 1–2 mm, free part 7 mm long, white, anther rectangular, 6–7 × 2 mm, pale yellow, pollen bright yellow; ovary narrow barrel-shaped, somewhat triangular in transverse section, 4–5 × 2–2.5 mm, strongly fluted when dry, densely short white- to green- or rufous-villous, 3-carpelled; styles 7–9 mm long, diameter increasing from base to apex, pale green, stigmas capitate, 3 mm diam., yellow. Fruit hanging, fusiform, hexagonal, seen only immature and green, glabrous; seeds not seen.

My above description agrees in most points with that given by Killip (1938, p. 541). Single axillary flowers and cauliflory have been observed on the same plants. Those racemes are actually short stems with bract-like leaves and either they continue normal vegetative growth, delayed or not, above the flowering segment, or they end their growth and become caducous after fruiting. The same type of stems with a basal inflorescence-like segment prolonged optionally by a normal leafy stem with axillary flowers is found toward the base of the main stem in unrelated *Passiflora* species like, to cite a few, *P. glandulosa* Cav. (subg. *Passiflora*), *P. coriacea* Juss. and *P. suberosa* L. (subg. *Decaloba* (DC.) Rchb.), or *P. balbis* Feuillet (subg. *Astrophea*).

Distribution and ecology.—*Passiflora jussieui* is known from French Guiana and Surinam in lowland rainforest. It has been collected in bloom in Jan, Mar–July, and Sep–Oct. June is the rainiest month and October the driest in French Guiana. It is likely that the species is not seasonal.

Etymology.—*Passiflora jussieui* has been named to honor Antoine Laurent de Jussieu (Juss.) who wrote some of the early important papers for the understanding of the Passifloraceae (1789, 1805a, 1805b).

In cultivation.—*Passiflora jussieui* is one of the easiest species to propagate in a notoriously difficult subgenus. It was cultivated in the Botanical Garden of ORSTOM in Cayenne. That single plant is documented by *Cremers 6324 & 7156*, *Feuillet 1366*, *de Granville 5525* (all cited below) and was photographed several

Fig. 1. *Passiflora jussieui* Feuillet. **A.** Flower with recurved sepals and petals; **B.** Immature fruits; **C.** Inflorescence with undeveloped leaves and flower buds. A & C: photographed by the author in October 2003, at the Butterfly World *Passiflora* Collection, Florida; B: photographed by M.-F. Prévost (CAY) in December 1985, at the ORSTOM Botanical Garden (not extant), Cayenne, French Guiana.

times (including Fig. 1B). At the end of October 1991, Linda K. Albert de Escobar took cuttings from this plant. The cuttings were distributed among American research institutions. I brought cuttings from that same plant that bloomed outdoors in southern Florida (Butterfly World) on a large arbor, and I grew two plants in a greenhouse in Maryland where it bloomed every year. The plants grown from these cuttings have been documented (flowers in spirit collections *Feuillet GH-0048* & *GH-0120*, both at US) and photographed (including Fig. 1A & C).

PARATYPES: (specimens kept at the British National Collection of Passiflora are coded by NCP) **SURINAM:** mountains around Emmaketen, 19 Sep 1959, fl, *A.G.H. Daniëls & F.P. Jonker 1227* (NY, U-now L) [apparently an error for F.P. Jonker & A.M.E. Jonker-Verhoef (cf. Ek 1991)]. **FRENCH GUIANA:** Briqueterie, Riv. Mana, Oct 1857, *P. Sagot s.n.* (K, P-2); Marouany, 1857, *P. Sagot 1287* (K, P, P); Ile de Cayenne, *L.C. Richard s.n.* (P, type of *Tacsonia citrifolia* Juss. ex DC., nom. illeg.); 7.5 km SW of Kourou as "Kouron," 24 Mar 1977, fl, *D. Roubik 72* (MO); Cayenne, 1821, *G. Perrottet s.n.* (G-DC, not cited by DC in 1828; photographs by Killip, 1925, F, US); Cayenne, 1850, *F. Leprieur s.n.* (P, P); Cayenne, 14 Jan 1980, fl, *J.-J. de Granville 5525* (CAY-2); Jardin Botanique ORSTOM, Cayenne, origin probably the Approugue River Basin, 2 Jun 1980, fl, *G. Cremers 6324* (CAY-2); idem, 23 Apr 1981, fl, *G. Cremers 7156* (CAY, US); idem, 6 Apr 1984, fl, *C. Feuillet 1366* (CAY); Mataroni River, 52°10.931W, 4°13.306N, 5 May 2001, fl, *S.A. Mori et al. 25297* (CAY, NY, US); Rignon's farm, road to Cacao, 1 km from road Cayenne - Régina (RN 2), 52°25'W, 4°33'N, 28 Jul 2005, fl, *M.-F. Prévost 4878* (CAY, US); Road Le Gallion - Tonate, near Montsinéry bridge, 11 Oct 1970, sterile, *W. Benson s.n.* (CAY); Route de St.-Élie, near Sinnamary, 19 Mar 2009, sterile, *R.J.R. Vanderplank, C. Feuillet & M. Vecchia 1619/09* (CAY, K, NCP); Saut Coumarou, 30 m, 52°54'W, 4°42'N, 27 Oct 1992, fl, *B. Bordenave 402* (CAY-2, P); Savane Renner, 18 Apr 1996, fl, *G. Cremers & J.-J. de Granville 14457* (CAY).—**UK:** Cultivated in the UK, British National Collection of *Passiflora*, plants origin in French Guiana near Tonnegrande in 1999, Feb 2008, fl., *R.J.R. Vanderplank 1395/08* (NCP) & *1521/08* (NCP).

In section *Capreolatae*, among the lianas with the foliar nectaries in adaxial position at the apex of the petiole, *P. jussieui* can be identified as follows:

1. Floral tube funnel-shaped ____ **P. cardonae** Killip
1. Floral tube campanulate to cylindric.
   2. Leaf blades membranaceous ____ **P. skiantha** Huber
   2. Leaf blades coriaceous.
      3. Leaf blades with a marginal dark band; sepals 1–1.5 as long as the floral tube.
         4. Leaf blades with a marginal dark band 1 mm wide; pedicel 3–6 mm long.
            5. Corona in 3 series, the outermost filaments subdolabriform, 12–15 mm long, those of the two inner series narrow linear, 2–3 mm long ____ **P. cauliflora** Harms
            5. Corona in 4–5 series, the outermost filaments subdolabriform, 18 mm long, those of the 2–3 middle series thick, 3–6 mm long, the innermost narrowly linear, 1–2 mm long, recurved in the tube ____ **P. jussieui** Feuillet
         4. Leaf blades with a marginal dark band up to 0.5 mm wide; pedicel 4–9 mm long ____ **P. cerradensis** Sacco
      3. Leaf blades with or without a marginal dark band; sepals more than twice as long as the floral tube.
         6. Leaf blades 12–35 cm long with a narrow marginal dark band abaxially; flowers 5–6.5 cm long ____ **P. maguirei** Killip
         6. Leaf blades 4.5–12 cm long without a marginal dark band; flowers less than 4 cm long ____ **P. cardonae** Killip

ACKNOWLEDGMENTS

This work could not have been completed without the help of the curators of the herbaria CAY, F, G, K, MO, NY, and P who hosted me in their institution or made available to me the material in their care. This is number 165 in the Smithsonian's Biological Diversity of the Guiana Shield Program publication series.

REFERENCES

DE CANDOLLE, A.P. 1828. Passifloreae. Prodromus 3:321–337.

EK, R.C. 1991. Index of Suriname plant collectors. Flora of the Guianas, suppl. ser. 2:1–97.

DE JUSSIEU, A.L. 1789. Genera plantarum. Hérissant & Barrois, Paris.

DE JUSSIEU, A.L. 1805a. Premier mémoire sur quelques nouvelles espèces du genre *Passiflora*, et sur la nécessité d'établir une famille des passiflorées. Ann. Mus. Hist. Natur. 6:102–116.

DE JUSSIEU, A.L. 1805b. Second mémoire sur la famille des passiflorées, et particulièrement sur quelques espèces nouvelles du genre *Tacsonia*. Ann. Mus. Hist. Natur. 6:388–396.

KILLIP, E.P. 1938. The American species of Passifloraceae. Publ. Field Mus. Nat. Hist., Bot. Ser. 19:1–613.

Masters, M.T. 1871. Contributions to the natural history of the Passifloraceae. Trans. Linn. Soc. 27:593–645.

McNeill J., F.R. Barrie, H.M. Burdet, V. Demoulin, D.L. Hawksworth, K. Marhold, D.H. Nicolson, J. Prado, P.C. Silva, J.E. Skog, J.H. Wiersema, and N.J. Turland 2006. International code of botanical nomenclature (Vienna Code). Regnum Veg. 146. A.R.G. Gantner Verlag KG, Ruggell.

Roemer, M.J. 1846. Passifloraceae. Prospect Fam. Nat. Syn. Monogr. 2:125–207.

Salisbury, R.C. 1796. *Passiflora* (154–156). In: Prodromus stirpium in horto ad chapel Allerton vigentium. s.n., London.

FOLIA TAXONOMICA 19. TYPIFICATIONS IN *DILKEA* (PASSIFLORACEAE)

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ABSTRACT

The types for the name of two species of *Dilkea* (Passifloraceae) are designated and the obscure name *Dilkea helleborifolia* is discussed.

RÉSUMÉ

Les types de deux noms d'espèces de *Dilkea* (Passifloracées) sont désignés et le nom obscur *Dilkea helleborifolia* est discuté.

Typifications in *Dilkea* Mast.

Dilkea johannesii Barb. Rodr., Vellosia ed.1, 1:24, pl. 10. 1888; ed. 2, 1:22 & 80 (caption); 3: t. 10. 1891. (**Fig. 1**). TYPE: BRAZIL. AMAZONAS: Manaus (LECTOTYPE, here designated: Barbosa Rodrigues 3: t. 10, 1891).

Dilkea ulei Harms, Verhandl. Bot. Verein. Brandenburg 48:184. 1906. TYPE: BRAZIL. AMAZONAS: Manaus, Feb 1901, *E.H.G. Ule 5381a* (LECTOTYPE, here designated: MG; HOLOTYPE: B, destroyed in 1943). About the fate of the Berlin (B) collections during WWII, see Hiepko (1987).

Although not as well-known as the destruction of the herbarium in Berlin in 1943, the loss of the herbarium of the Botanical Museum of Amazonia in Manaus had a serious impact on the nomenclature of Amazonian plants. According to Mori and Castaño Ferreira (1987), João Barbosa Rodrigues was the first and last director of the Botanical Museum of Amazonia in Manaus. When he was nominated director of the Museum in Rio de Janeiro in 1890, soon the Botanical Museum of Amazonia was closed and ultimately all the herbarium specimens were lost. Among those, all Barbosa Rodrigues types collected before 1890 but one found later in a book, were lost.

The first edition of *Vellosia* (Barbosa Rodrigues 1888) had so many errors that Barbosa Rodrigues stopped the publication (Barbosa Rodrigues 1891a) and destroyed the copies at hand. The second edition corrected most of the errors. The botanical illustrations (Barbosa Rodrigues 1891b) are reprints of Barbosa Rodrigues original artwork, and in the case of *D. johannesii*, "tabula nostra X" cited above is the only original element still extant. It is diagnostic with drawings and diagrams of the flower, fruit, and ovule. Therefore I designate here tabula/estampa X (Fig. 1) as the lectotype of *Dilkea johannesii* Barb. Rodr. 1888, dedicated to his son João Barbosa Rodrigues Jr.

An overlooked name in *Dilkea*

Barbosa Rodrigues (1891b) said that the genus *Dilkea* was described by Masters in "Flora Baziliensis" (sic) in 1872 with two species, *D. retusa* and *D. acuminata*, and two more added late, *D. helleborifolia* (as "helliborifolia") and *D. wallisii*, and that he (Barb. Rodr.) is adding one more (*D. johannesii*, see above). In fact Masters described *Dilkea* and the first two species in 1871. In "Flora Brasiliensis," Masters (1872) gave a treatment of the Passifloraceae where *Dilkea* is on columns 533–535 (columns, not pages are numbered), and *Passiflora* on 542–622. Then, also in 622, he described two species under "Curae posteriores," *Dilkea wallisii* and *Passiflora helleborifolia* (as "helliborifolia") after illustrations from Wallis. *Dilkea helleborifolia* is probably an illegitimate name as one could argue that there was no intent to make a new combination, merely a mistake on the genus. In any case, *Passiflora helleborifolia* Wallis ex Mast. and *D. helleborifolia* are synonyms of *P. pedata* L. 1753 as noted by Killip (1938) for the former. As far as I know, nobody cited *D. helleborifolia* since 1891.

J. Bot. Res. Inst. Texas 4(2): 615 – 617. 2010

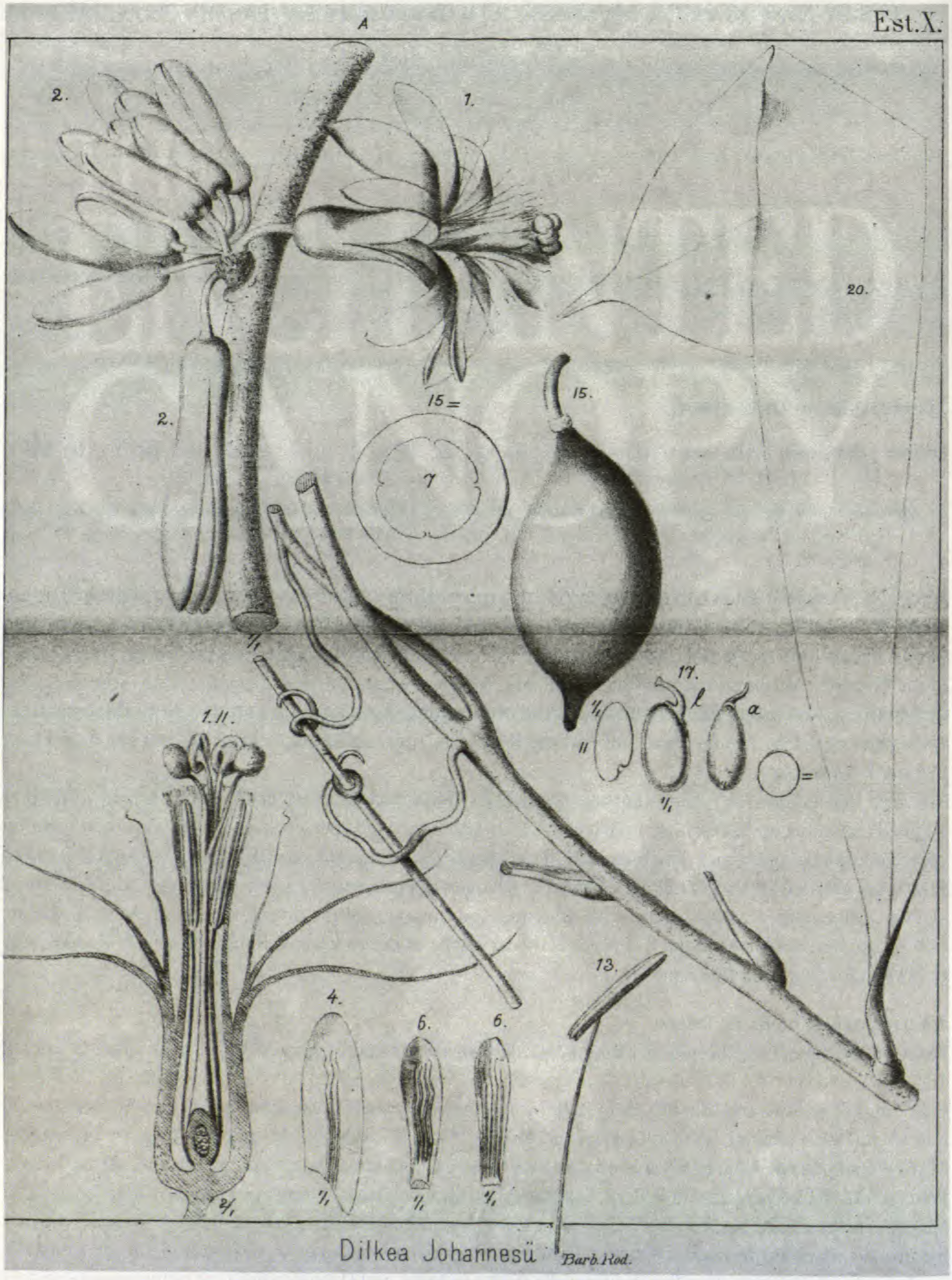

Fig. 1. Estampa 10, lectotype of *Dilkea johannesii* Barb. Rodr.: 1. Open flower in a fascicle on woody stem; 1//. Flower cut open longitudinally; 2. Flower buds; 4. Sepal; 6. Petals; 13. Stamen; 15. Fruit; 15=. Fruit cut transversally; 17. Seeds frontal and lateral views, and longitudinal and transversal cuts; 20. Leaf on a climbing stem with tendrils. In the original print, the frame is 25.5 × 20 cm.

ACKNOWLEDGMENTS

This work could not have been completed without the help of the curators of the cited herbaria who hosted me in their institution or made available to us the material in their care. This is number 166 in the Smithsonian's Biological Diversity of the Guiana Shield Program publication series.

REFERENCES

Barbosa Rodrigues, J. 1888. Ordo Passifloreae Endl. Vellosia, ed. 1, 1:24–31.

Barbosa Rodrigues, J. 1891a. Prologo da 2ª Adição. Vellosia, ed. 2, 1:IX–XI.

Barbosa Rodrigues, J. 1891b. Ordo Passifloreae Endl. Vellosia, ed. 2, 1:21–31; 3: tab. 10.

Hiepko, P. 1987. The collections of the Botanical Museum Berlin-Dahlem (B) and their history. Englera 7: 219–252.

Killip, E.P. 1938. The American species of Passifloraceae. Publ. Field Mus. Nat. Hist., Bot. Ser. 19:1–613.

Masters, M.T. 1872. Passifloraceae. In: C.F.P. von Martius, ed., Fl. Bras. Soc. 13, pt. 1:530–654.

Mori, S.A. and F.Castaño Ferreira. 1987. A distinguished Brazilian botanist, João Barbosa Rodrigues (1842–1909). Brittonia 39:73–85.

BOOK NOTICE

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TAXONOMIC NOTES ON THE GENERA *STENOTIS* AND *CARTERELLA* (RUBIACEAE) AND TRANSFER OF *HEDYOTIS GREENEI* TO *STENOTIS*

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ABSTRACT

A limited review of the genus *Stenotis* (Hedyotidae/Spermacoceae: Rubiaceae) is provided using morphological characters. The circumscription of the genus *Stenotis* is expanded with **Hedyotis greenei** A. Gray transferred to the genus. The genus *Carterella*, evidently closely related to *Stenotis* on the basis of some structures, geography, cytological data, and recent molecular phylogenetic study, is considered as generically distinct.

RESUMEN

Los limites del género *Stenotis* (Hedyotideae/Spermacoceae: Rubiaceae) se discuten, **Hedyotis greenei** se transfiere al género. *Carterella* que se considera como un género estrechamente vinculado pero distinto.

The genus *Stenotis* Terrell (2001) includes seven species restricted to Baja California and Arizona, two annuals and five perennial herbs or small shrubs. The present study is a reconsideration of taxonomic relationships in the genus. Five of the species have chromosome numbers of $n = 13$ (Lewis 1962a), a number so far known only in *Stenotis* and *Carterella* Terrell in the *Hedyotis* L./*Houstonia* L. relationship. A study by Church (2003), using nuclear and chloroplast DNA sequences, included two species of *Stenotis*, *S. arenaria* and *S. asperuloides*, and the single species, *Carterella*, and concluded that they were closely related to each other but in a phylogenetic position outside of the *Houstonia* L./ *Stenaria* Terrell clade. The *Stenotis* clade remains most distinct in its $n = 13$ chromosome number, and its near restriction to Baja California.

In our previous studies of *Hedyotis*/*Houstonia* relationship, we have emphasized the taxonomic importance of seed morphology. In the case of *Stenotis* the seeds of all species have punctiform hila on or near the middle of the seeds. The annual species differ somewhat from the perennials in having the ventral, hilar face somewhat enlarged and rounded (Table 1). Seeds of four species were shown by Terrell (2001, Fig. 1).

COMPARISON OF SPECIES

The present study is an addendum to the monograph of *Stenotis* by Terrell (2001), and a key to the species is contained in that study. Six of the seven species of *Stenotis* are considered here. The present study does not deal with *S. peninsularis* (Brandegee) Terrell, a very rare, twice-collected species. Of the remaining species, we propose, based on our investigation, that one species in the previous treatment (Terrell 2001) is of hybrid origin and *Hedyotis greenei* (A. Gray) W.H. Lewis be transferred from *Hedyotis* into *Stenotis* as discussed below. a probable older name for the previously recognized *Stenotis arenaria* (Rose) Terrell.

Within *Stenotis*, the type species *S. mucronata*, is distinguished from all other species by having fasciculate morphology, described as follows: Stem densely branched and with many short internodes, leaves often sessile, unusually small, 3–18 × to ca. 2 mm, numerous, linear or subterete, thick and rigid, strongly revolute, tightly clustered at the nodes in groups of 3–8 or more. This combination of characters gives the plants a densely unique appearance. At least several species of *Arcytophyllum* Willd. ex Schult. in Roem. & Schult., a related South and Central American genus, have similar fasciculate morphology; the relationships of these species to *Stenotis* has not been tested, and is the subject of a separate study.

J. Bot. Res. Inst. Texas 4(2): 619 – 623. 2010

TABLE 1. It is not possible to include *Stenotis greenei* in this table, which was provided at the time of the monograph to compare the established species of the genus. It can be noted here that *S. greenei* is closely related to *S. arenaria*, but the extent of this closeness remains to be determined. If the two prove conspecific, the name *S. greenei* would have priority.

	mucronata	brevipes	australis	arenaria	asperuloides
HABIT	small shrubs/ herbs	small shrubs/ herbs	per. woody herbs	small annual herbs	small annual herbs
STEMS	to 9 dm tall	to ca. 1 m.	to 6 dm tall	0.3–3.0 dm tall	to 2.8 dm tall
texture	woody, stout	herb./woody base	woody toward base	herbaceous	herbaceous
branching	dense	spreading	spreading	spreading	diffusely branched
vestiture	glabrate or glabrous	glabrous	glabrous/puber.	glabrous/scaber.	glabrous/ puber.
LEAVES L × W	3–18 × to 1.8 mm	5–30(–50) × 0.3–2	to 40 × to 2	5–40 × 0.5–6.0	3–30 × 0.3–3.5
shape	linear/subterete	linear or filiform	linear or filiform	narr.oblanc.to linear	linear or filiform
fasciculate	densely	not fasciculate	not fasciculate	not fasciculate	not fasciculate
texture	thick, rigid	herbaceous	herbaceous	herbaceous, thin	herbaceous
apex	mucronulate	apiculate/mucronul.	obtuse to apiculate	acute to apiculate	obtuse to apiculate
PEDICELS/SESSILE	subsess./ped. to 10 mm	subsess./ped. to 12	sessile/ped. to 10	sessile/ped. to 16	sessile/ped. to 30
COROLLAS L. mm	8–14	8–18	4–11	2–6	3–11
shape	tubular	tubular	tubular	short-tubular	short-tubular
tubes mm	7–10	6–13	3–7	1–3.5	2–7
lobes	1.5–4.0 × 1–3	1.5–5.0 × 1–3	1.5–3.5 × 1–2	1–3 × 0.5–2.0	1.5–5.0 × 1–4
lobes/tubes	tubes. 3–4 × longer	tubes 3–4 × longer	tubes 2 × longer	equal	tubes sl. longer
vesture	glabrate	glabrous	glab/puber. within	glabrous	puberulent
CAPSULES mm	1.7–3.5 × 2–3.5	1.5–3.5 × 1.5–3.5	2–4 × 2–4	2–4 × 2–4	1.3–5.0 × 1.3–2.0
shape	subglobose	subglobose	subglobose	subglobose/ obovoid	turbinate/ obl/ell
l/w	equal/sl.wider than long	equal	equal	equal	longer than wide
SEEDS	0.65–0.95 × 0.35–0.6	0.6–1.0 × 0.3–0.7	0.45–0.8 × 0.3–0.6	0.4–0.9 × 0.25–0.60	0.3–0.6 × 0.2–0.4
compression	moderate	moderate/strong	moderate	slight	slight/ moderate
thickness	moderate	moderate	moderate	thick	thick
outline shape	ellipsoid/oblongoid	broadly ellipsoid	oblongoid/irregular	obl./ell./irreg.angul.	ell./obl.
ventral face	flat/concave	concave/sl. convex	flat/sl. convex	str.convex, rounded	str.convex, rounded
hilum	centric punctiform hilum	centric punct. hilum	centric punct. hilum	centric punct. hilum	centric punct. hilum

In spite of the fasciculate morphology in *Stenotis mucronata* (Benth.) Terrell, three perennial species are clearly rather closely related. *Stenotis mucronata* has woody, stout stems to ca. 9 dm tall. The perennial species most similar to *S. mucronata is S. brevipes* (Rose) Terrell, which has herbaceous stems to ca. 1 m tall. *Stenotis brevipes* does not have fasciculate morphology and the herbaceous leaves are 5–50 mm long. When the two species are compared in detail (Table 1), we find that, aside from the fasciculate morphology, they are generally similar in calyx, corolla, capsules, and seeds.

A third perennial species, *S. australis* (I.M. Johnst.) Terrell, is somewhat smaller, ca. 6 dm tall, with stems woody toward the base (Table 1). It differs from *S. brevipes* mainly in having corollas somewhat shorter and corolla tubes 2 times longer than the lobes instead of 3–4 times longer. *Stenotis australis* has a more restricted

range south of La Paz in lower Baja California, whereas *S. brevipes* is rather widely distributed northward. Terrell (2001) examined 13 herbarium specimens of *S. australis*, and 41 collections of *S. brevipes*.

The two annual species, *S. arenaria* (Rose) Terrell and *S. asperuloides* (Benth.) Terrell, occur in the Cape region of Baja California south of La Paz. Both have short, slender herbaceous stems. When the two species are compared with each other (Table 1) they differ as follows: Leaves slightly larger in *S. arenaria* and narrowly oblanceolate to linear compared to linear or filiform in *S. asperuloides*. Pedicels in *S. arenaria* are to 16 mm long, compared to 30 in *S. asperuloides*. Corollas in *S. arenaria* 2–6 mm long vs. 3–11 mm. Corolla tubes and lobes about equal in *S. arenaria*, but slightly longer in *S. asperuloides*. Capsules equally long and wide in *S. arenaria*, but slightly longer than wide in *S. asperuloides*. Capsule shape in *S. arenaria* often subglobose but often turbinate in *S. asperuloides*. Seeds are similar in both species. We conclude that the two annual species have several differences, but are similar in important characters such as seeds.

Comparison of the annual *S. arenaria* with the perennial species having herbaceous stems, *S. brevipes* (Table 1), shows differences besides those of plant size and life cycle: *S. arenaria* has corollas only 2–6 mm long and corolla tubes about equal in length to the lobes, but *S. brevipes* has corollas 8–18 mm long with tubes 3–4 times longer than lobes. Seeds of *S. arenaria* are slightly compressed and thick with the ventral face strongly rounded. Seeds of *S. brevipes* are moderately compressed with both similar faces concave or convex. These differences in reproductive characters suggest that these two species are more distantly related.

The other annual species, *S. asperuloides*, may also be compared (Table 1) with *S. brevipes*. *Stenotis asperuloides* has pedicels to 30 mm long, corollas 3–11 mm long and corolla tubes only slightly longer than the lobes. *Stenotis brevipes* has pedicels to 12 mm long, corollas 8–18 mm long, and tubes 3–4 times longer than the lobes. The capsules of *S. asperuloides* are often turbinate and the length of capsules is longer than its width. The capsules of *S. brevipes* are often subglobose and equally long as wide. Seeds of *S. asperuloides* and *S. brevipes* differ as in *S. arenaria* and *S. brevipes*.

It was noted above that all three perennial species are closely related to each other in spite of the occurrence of fasciculate morphology in *S. mucronata*. The two annual species appear to be basically similar to each other in important characters such as seeds, but in other characters they are distinct. It is concluded that the annual and perennial species appear to be rather distinct groups, but are correctly placed in the same genus, especially as no other genus except *Carterella* appears to be related to *Stenotis*.

Status of *Stenotis gracilenta*

Johnston (1924) described *Houstonia gracilenta* and noted it resembled both *H. brevipes* and *H. mucronata*, "particularly the latter." Wiggins (1980) stated that *H. gracilenta* occurred on several islands in the Gulf of California. Both of the species that Johnston compared with his new species are well known to occur on these islands, and there is at least one collection of *S. mucronata* from San Diego Island (*Moran 9592*, MICH), the type locality for *S. gracilenta* (Terrell 2001).

Stenotis gracilenta was tentatively treated as a species by Terrell (2001), who accompanied it with nomenclatural data and a full description, but suggested that it is likely to be a hybrid between *S. brevipes* and *S. mucronata*. Terrell (2001) provided a description to *S. gracilenta* and included it in the key to species. The evidence from the intermediate structure and co-occurrence with putative parents is sufficient to confirm its hybrid status. It may be listed as *Stenotis* × *gracilenta* (I.M. Johnston) Terrell.

Transfer of Hedyotis greenii to genus Stenotis

Terrell (2001) stated that an additional species, *Hedyotis greenei* A. Gray, occurs only in Arizona and is closely related to *Stenotis arenaria*, or the same species, but it was excluded from his treatment pending further study. Since 2001 Terrell has not found time or opportunity for further study, however, data strongly suggest that *Hedyotis greenei* is a *Stenotis*. It will take other studies to determine whether it is truly distinct from the very morphologically similar *Stenotis arenaria*, but they are clearly both members of *Stenotis*. Whether it is distinct from *S. arenaria* or is the same species or a variety remains to be determined. The geographical separation of the two taxa—lower Baja California and Arizona amounts to ca. 960 km (600 miles). It may be noted that

the name *S. greenei* (1883) predates the name *S. arenaria* (Rose 1890). It is not possible to properly include *Stenotis greenei* in Table 1, which was provided to compare the established species; it is pointed out here that *S. greenei* is closely related to *S. arenaria*, but the extent of this closeness remains to be determined.

Stenotis greenei (A. Gray) Terrell & H. Rob., comb. nov. *Oldenlandia greenei* A. Gray, Proc. Acad. Arts 19:77.1883. *Hedyotis greenei* (A. Gray) W.H. Lewis, Rhodora 63:222.1961. *Houstonia greenei* (A. Gray) Terrell, Phytologia 59:79.1985. Type: U.S.A. New Mexico: Pinos Altos Mountains, 1880, *E.L. Greene 149* (holotype GH!). Paratype: ARIZONA: Ramsey's Canyon, S. Arizona, 1882, *Lemmon 2719* (GH!, attached to the same sheet with the type).

Small annual herb with slender roots. Stems 3–16 cm tall, slender, quadrangulate to terete, erect, glabrous or scabridulous, with slender branches 2–10 cm long from any or all nodes. Leaves 5–32 × 0.5–5.0 mm, sessile or with short petioles, thin, 1-nerved, narrowly oblanceolate, narrowly elliptic, or linear, glabrous. Stipules to 1 mm long, scarious, whitish, with several marginal teeth. Inflorescence with heterostylous flowers, earliest flowers sessile in axils of peduncles or branches, surpassed by later peduncles bearing sessile or pedicellate flowers. Pedicels to ca. 16 mm long, erect, buds obovate. Hypanthium glabrous; calyx lobes 0.5–2.0 × 0.2–0.7 mm, lanceolate or narrowly lanceolate. Corollas 2–5.5 mm long, funnelform, white; tubes 1–3.5 mm long, 0.5–1.5 mm wide at throat, glabrous within; lobes 1–2 × 0.5–2 mm, ovate. Pin flowers with stigma lobes 0.2–0.5 mm long, linear, exserted to ca.1 mm long beyond throat, anthers at or just below corolla throat. Thrum flowers with anthers 0.2–0.4 mm long, oblong, subsessile or on filaments to 1 mm long, exserted to ca. 1 mm beyond throat, stigmas near midpoint of tube. Capsules 2–4 mm long and wide, ¾–⅞ inferior, subglobose, tan with 8 darker nerves, thin-walled, dehiscing loculicidally and septicidally. Seeds 0.5–0.8 × 0.3–0.45 mm, brown, oblong or elliptic, dorsal face flattish or convex, ventral face strongly rounded with punctiform apical hilum, testa reticulate, areole (cell) walls sinuous or straight. Chromosome number not known.

Phenology.—Flowering August–September; fruiting September–October.

Habitats and distribution.—Gravelly soil, on boulders or bedrock outcroppings, rocky slopes; pine-oak forests, oak-juniper; 1500–2450 m (5000–8000 ft). Southeastern and central Arizona (Cochise, Graham, Greenlee, Pima, Santa Cruz, Yavapai counties), southwestern New Mexico.

Additional nomenclatural notes.—Gray's protologue listed two collections. The first was *E.L. Greene 149* from New Mexico (see above). This citation was set off by a period and space and was followed by citation of "S. Arizona, in Ramsey's Cañon, 1882, *Lemmon*." We take it that the first citation is a holotype (not a syntype) as it was distinctly set off and the name of the collector, Greene, was used in the species name. The second name is a paratype, not a syntype, as it was not equal in status to the first name.

Representative Specimens. **ARIZONA. Cochise Co.:** Blacktail Canyon, Fort Huachuca Military Reservation, *Goodding 390-61* (ARIZ); pine-oak forest, 6200 ft, Rucker Canyon, Chiricahua Mts., *Gould & Haskell 4551* (ARIZ); Huachuca Mts., Miller Canyon road, 2.3 mi W of Hwy. 92, *McLaughlin & Hoffman 5242* (ARIZ). **Graham Co.:** near Chlarsons Mill, Pinaleno Mts., 6500 ft, *Shreve 4376* (ARIZ). **Pima Co.:** Rincon Mts., 7900 ft, Manning Camp, *Blumer 3369* (ARIZ, DS, ISC, MO); near top of Mt. Baboquivari, 7500 ft, *Gould 4475* (ARIZ, CAS). **Santa Cruz Co.:** Madera Canyon, *Fletcher 2836* (UNM). **Yavapai Co.:** Prescott Pines Baptist Campground, *Keil 712* (ASU).

Relationships of the genus *Carterella*

The genus *Carterella* was established by Terrell (1987) based on *Bouvardia alexanderae*, a rare Baja.California species named by Annetta Carter in honor of her friend, Annie M. Alexander, for her assistance in a 1949 trip to Baja California. Annetta Carter was impressed by the "large white long-tubed salverform corollas" so assigned the species to *Bouvardia* (Carter 1955). Lewis (1962b) found that *Bouvardia alexanderae* has a chromosome number of $n = 13$, the same as the number for other Baja California species (Lewis 1962a) that are now placed in *Stenotis*. Later, Lewis (1968) transferred the species to *Hedyotis* L., using the broad interpretation of the genus that was in use at that time. Terrell and Robinson (2003) reported that *Hedyotis fruticosa* L., the type species, was related to a number of Asian species morphologically distinct from American species, consequently we restrict use of the name *Hedyotis* to Asian taxa.

Terrell (1987) renamed *Carterella* as a monotypic genus, discussed the morphology, and considered it distinct from *Hedyotis*. Church (2003) in molecular studies stated that the chloroplast data place *C. alex-*

anderae firmly within the *Stenotis* lineage. A question at the present time is whether *Carterella* (1987) and *Stenotis* (2001) are the same genus. Here the evidence is reexamined. Because *Carterella* is in an unresolved or basal position in the *Stenotis* clade (Church 2003), we suggest the lineage includes two genera, one being the monophyletic *Carterella*.

Carterella alexanderae is a narrowly restricted endemic confined to granitic canyons in the mountains east and southeast of La Paz in lower Baja California. It is quite different from the species of *Stenotis* discussed here, and is a conspicuously attractive species with flower parts two to several times longer or larger than those of *Stenotis* (Terrell 1987, Fig. 1). Its calyx lobes are 3–10 mm long versus 0.5–3 in *Stenotis* species; corollas are 30–50 mm long versus 2–18; corolla tubes 25–41 mm long versus 1–13; corolla lobes 4.5–10 mm long versus 1–5; anthers 1.8–3 mm long versus 1–1.7; and stigma lobes 1–5 mm long versus 1–1.8. In fruit the capsules length and width are 3–6 × 3–6 mm versus 1.3–5 × 1.3–4, significantly larger than most if not all previously studied taxa in the Hedyotideae (s.s.). These measurements indicate that the length and width of important flower and fruit characters are quantitatively different in *Carterella*.

Our previous work on the Hedyotideae (s.s.) found that seed morphology provided significant evidence concerning the taxonomic status of genera and species. In studying *Carterella alexanderae* we found this again to be true. Seeds of *Carterella alexanderae* are strongly to moderately, laterally compressed with a hilum at the peak (Terrell 1987, Figs. 2, 3) whereas seeds of *Stenotis* are somewhat dorsiventrally compressed, of an ellipsoid type with a punctiform hilum on or near the center of the ventral face. *Carterella alexanderae* is considered to be unique in having this strong lateral compression. Previous studies have not shown species of *Hedyotis/Houstonia* relationship with such extreme morphology. Here it may also be noted that *Bouvardia* seeds are dorsiventrally compressed with wide, papery, conspicuous wings and a chromosome number of 9.

Terrell (1987) stated that *Carterella alexanderae* "appears to be an offshoot or derivative of the same basic stock as that of the *Houstonia mucronata* group" (now *Stenotis*), perhaps long isolated and the result of considerable differentiation. This is shown by the striking quantitative differences in flower and fruit characters and the strong qualitative differentiation in seed morphology. We believe that *Carterella* should remain a monotypic genus.

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REFERENCES

Carter, A. 1955. A new species of *Bouvardia* (Rubiaceae) from Baja California, Mexico. Madrono 13:140–144.

Church, S.A. 2003. Molecular phylogenetics of *Houstonia* (Rubiaceae): descending aneuploidy and breeding system evolution in the radiation of the lineage across North America. Molec. Phylogen. Evol. 27:223–238.

Johnston, I.M.1924. Expedition of the California Academy of Sciences to the Gulf of California in 1921. Proc. Calif. Acad. Sci., ser. 4, 12:1173–1177.

Lewis, W.H. 1962a. Phylogenetic study of *Hedyotis* (Rubiaceae) in North America. Amer. J. Bot.49:855–865.

Lewis, W.H. 1962b. Chromosome numbers in North American Rubiaceae. Brittonia 14:285–290.

Lewis, W.H. 1968. Notes on *Hedyotis* (Rubiaceae) in North America. Ann. Missouri Bot. Gard. 55:31–33.

Terrell, E.E. 1987. *Carterella* (Rubiaceae), new genus from Baja California, Mexico. Brittonia 39:248–252.

Terrell, E.E. 2001. *Stenotis* (Rubiaceae), a new segregate genus from Baja California, Mexico. Sida 19:899–911.

Terrell, E.E. and H. Robinson. 2003. Survey of Asian and Pacific species of *Hedyotis* and *Exallage* (Rubiaceae) with nomenclatural notes on *Hedyotis* types. Taxon 52:775–782.

Wiggins, I.L. 1980. Flora of Baja California. Stanford University Press, Stanford, CA.

BOOK NOTICE

Sabeeha Merchant, Winslow R. Briggs, and Donald Ort (eds). 2010. **Annual Review of Plant Biology: Vol. 61.** (ISSN 1543-5008; ISBN 978-0-824-30661-8, hbk.). Annual Reviews, Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, U.S.A. (**Orders:** www.AnnualReviews.org, science@annualreviews.org, 1-800-523-8635, 1-650-493-4400). $89.00 indiv., 740 pp., 7⅞" × 9⅞".

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J. Bot. Res. Inst. Texas 4(2): 624. 2010

TRANSFER OF *HEDYOTIS INTRICATA* TO *ARCYTOPHYLLUM* (RUBIACEAE)

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ABSTRACT

The taxonomic relationships of *Hedyotis intricata* Fosberg, native to northern Mexico, southwest Texas, and southern New Mexico, were studied. We conclude that the closest relationships are to *Arcytophyllum*, necessitating a new name, **A. fasciculatum** (A. Gray) Terrell & H. Rob. Nomenclatural and distributional data, and a full description are provided.

RESUMEN

Las relaciones taxonómicas de *Hedyotis intricata* Fosberg, nativa del norte de México, en el suroeste de Texas y el sur de Nuevo México, fueron estudiadas. Se concluye que las relaciones más estrechas son con *Arcytophyllum*, haciendo necesario un nuevo nombre, **A. fasciculatum** (A. Gray) Terrell & H. Rob. Se proporcionan datos nomenclaturales y de distribución, y una descripción completa.

The taxonomic relationships of *Hedyotis intricata* Fosberg, native to northern Mexico, southwest Texas, and southern New Mexico, were studied. Morphological evidence indicates a close relationship to the genera *Stenotis* and *Arcytophyllum*. After comparison of representative specimens of these genera, we conclude that *Arcytophyllum thymifolium* (Ruiz & Pavon) Standl. is the most closely related species to *Hedyotis intricata*. Transfer of *Hedyotis intricata* to *Arcytophyllum*, nomenclature, distribution, and representative collections are provided below.

Arcytophyllum fasciculatum (A. Gray) Terrell & H. Rob., comb. nov. *Houstonia fasciculata* A. Gray, Proc. Amer. Acad. Arts 17:203. 1882. *Hedyotis intricata* Fosberg, Lloydia 4:290. 1941, nom. nov., non *Hedyotis fasciculata* Bertoloni, 1850. Type: SW border of Texas at Presidio, Mexican Boundary Survey, *Bigelow* (lectotype, selected by Shinners (1949): GH; isolectotype: K).

Note.—The following syntypes were cited by Gray following the citation of the Bigelow collection: syntypes: NEW MEXICO: Organ Mountains, *G.R. Vasey*, 1881 (BM, GH, NY, US-2).MÉXICO. Coahuila: near Parras and Monclova, *Palmer*, 1880, 404 (GH, K, MO, NA, NY, US); 406 (GH, K, NA, NY, PH, US-2).

Distribution.—Rocky or gravelly slopes, arroyo banks, limestone ledges and crevices of cliffs, desert, semi-desert, pine-oak, pine-juniper; 1000–2400 m. Mexico: Coahuila, western Nuevo Leon, east and central Chihuahua, extreme north central Durango and Zacatecas; U.S.: southwestern Texas in southern Brewster (including Chisos Mts., Big Bend National Park) and Presidio counties, and south central New Mexico (Doña Ana and Otero counties).

Representative specimens: **UNITED STATES. NEW MEXICO. Doña Ana:** Ash Canyon, San Andreas Mts., 19 Jul 1936, *Parker* s.n. (ARIZ). **OTERO Co.:** mouth of Alamo Canyon, Sacramento Mts., 25 May 1932, *Wilkens 2135* (PH, US). **TEXAS. Brewster Co.:** Pine Canyon,Chisos Mts, Big Bend N. P., 17 Jun 1963, *Correll & Wasshausen 27876* (LL); near Boot Spring, 6500 ft.,Chisos Mts., 15–18 Jul 1921, *Ferris & Duncan 2815* (CAS); head of Blue Creek Canyon, Chisos Mts., 1 Jul 1931, *Moore & Steyermark 3323* (CAS, DS, GH, MICH, NY, PH, US); Lower Juniper Spring, 23 Jun 1937, *Warnock 897* (ARIZ, GH, TEX). **MEXICO. Chihuahua:** 39 air miles NE of Cd. Chih., near Mina La Nueva Esperanza, 10 Sep 1980 *Henrickson 18453* (TEX, US); Sierra de los Pinos, Dec 1937, *LeSueur 1532* (ARIZ, F, SMU, TEX). **COAHUILA:** 1.5 km NE of Rancho de San Marcos, 12 Jun 1972, *Chiang, Wendt, Johnston 7674* (ASU, TEX, US); Sierra de la Madera, Canon del Pajarito, 6 Sep 1939, *Muller 3174* (F, GH, LL, MICH, NA, SMU); 13 mi W of Saltillo, 5400 ft, *Ripley & Barneby 13277* (CAS, NY); 9 km S of Parras on Sierra Negros, 3 Jul 1941, *Stanford et al. 171* (ARIZ, DS, GH, MO, NY); **DURANGO:** 57 km WSW of Ceballos, 1 Nov 1972, *Chiang et al. 9999* (CAS, LL, TEX, US). **NUEVO LEON:** Canyon de Grutas, 31 mi NW of Monterrey, 26 Jun 1966, *Ward 5677* (FLAS, MICH). **ZACATECAS:** 23 mi W of turnoff to Cedros from hwy 54, 1 Aug 1975, *Engard & Gentry 677* (ASU, LL).

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REFERENCES

Mena V., P. 1990. A revision of the genus *Arcytophyllum* (Rubiaceae: Hedyotideae). Mem. New York Bot. Gard. 60:1–26.

Terrell, E.E. 2001. *Stenotis* (Rubiaceae), a new segregate genus from Baja California, Mexico. Sida 19:899–911.

NOMENCLATURAL TRANSFERS IN THE GENUS *MYRSINE* (MYRSINACEAE) FOR NEW CALEDONIA

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ABSTRACT

The names of 55 taxa of New Caledonia *Rapanea* are transferred to *Myrsine*. Thirty-eight new combinations are made including: **M. albiflorens** (M. Schmid) Ricketson & Pipoly; **M. arborea** (M. Schmid) Ricketson & Pipoly; **M. asymmetrica** (Mez) Ricketson & Pipoly; **M. belepensis** (M. Schmid) Ricketson & Pipoly; **M. boulindaensis** (M. Schmid) Ricketson & Pipoly; **M. citrifolia** (Mez) Ricketson & Pipoly; **M. diminuta** (Mez) Ricketson & Pipoly; **M. discocarpa** (M. Schmid) Ricketson & Pipoly; **M. dumbeaensis** (M. Schmid) Ricketson & Pipoly; **M. grandifolia** (S. Moore) Ricketson & Pipoly; **M. humboldtensis** (M. Schmid) Ricketson & Pipoly; **M. katrikouensis** (M. Schmid) Ricketson & Pipoly; **M. koghiensis** (M. Schmid) Ricketson & Pipoly; **M. kuebiniensis** (M. Schmid) Ricketson & Pipoly; **M. lecardii** (Mez), Ricketson & Pipoly; **M. macrophylla** (Mez) Ricketson & Pipoly; **M. mcphersonii** (M. Schmid) Ricketson & Pipoly; **M. memaoyaensis** (M. Schmid) Ricketson & Pipoly; **M. modesta** (Mez) Ricketson & Pipoly; **M. munzingeri** (M. Schmid) Ricketson & Pipoly; **M. nigricans** (M. Schmid) Ricketson & Pipoly; **M. nitens** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly; **M. oblanceolata** (M. Schmid) Ricketson & Pipoly; **M. obovalifolia** (M. Schmid) Ricketson & Pipoly; **M. ouameniensis** (M. Schmid) Ricketson & Pipoly; **M. ouazangouensis** (M. Schmid) Ricketson & Pipoly; **M. ovicarpa** (M. Schmid) Ricketson & Pipoly; **M. paniensis** (M. Schmid) Ricketson & Pipoly; **M. parvicarpa** (M. Schmid) Ricketson & Pipoly; **M. poumensis** (M. Schmid) Ricketson & Pipoly; **M. pronyensis** (Guillaumin) Ricketson & Pipoly; **M. spissifolia** (M. Schmid) Ricketson & Pipoly; **M. stenophylla** (Mez) Ricketson & Pipoly; **M. taomensis** (M. Schmid) Ricketson & Pipoly; **M. tchingouensis** (M. Schmid) Ricketson & Pipoly; **M. verrucosa** (M. Schmid) Ricketson & Pipoly; **M. yateensis** (M. Schmid) Ricketson & Pipoly. New combinations and statuses are made for sixteen former varieties and one forma, raising them to the rank of subspecies, including: **M. asymmetrica** (Mez) Ricketson & Pipoly subsp. **magnifolia** (M. Schmid) Ricketson & Pipoly; **M. asymmetrica** (Mez) Ricketson & Pipoly subsp. **paniensis** (M. Schmid) Ricketson & Pipoly; **M. asymmetrica** (Mez) Ricketson & Pipoly subsp. **parvifolia** (M. Schmid) Ricketson & Pipoly; **M. lanceolata** Pancher & Sébert subsp. **ouenarouensis** (M. Schmid) Ricketson & Pipoly; **M. macrophylla** (Mez) Ricketson & Pipoly subsp. **menaziensis** (M. Schmid) Ricketson & Pipoly; **M. modesta** (Mez) Ricketson & Pipoly subsp. **coriaria** (M. Schmid) Ricketson & Pipoly; **M. modesta** (Mez) Ricketson & Pipoly subsp. **tiebaghiensis** (M. Schmid) Ricketson & Pipoly; **M. nigricans** (M. Schmid) Ricketson & Pipoly subsp. **ouinensis** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly subsp. **balabioensis** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly subsp. **boulindaensis** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly subsp. **kaalaensis** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly subsp. **mueoensis** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly subsp. **piroguensis** (M. Schmid) Ricketson & Pipoly; **M. oblanceolata** (M. Schmid) Ricketson & Pipoly subsp. **doensis** (M. Schmid) Ricketson & Pipoly; **M. parvicarpa** (M. Schmid) Ricketson & Pipoly subsp. **amossensis** (M. Schmid) Ricketson & Pipoly; **M. parvicarpa** (M. Schmid) Ricketson & Pipoly subsp. **pachyphylla** (M. Schmid) Ricketson & Pipoly; **M. verrucosa** (M. Schmid) Ricketson & Pipoly subsp. **microphylla** (M. Schmid) Ricketson & Pipoly. Three binomials are lectotypified: **M. citrifolia** (Mez) Ricketson & Pipoly; **M. lecardii** (Mez), Ricketson & Pipoly; **M. stenophylla** (Mez) Ricketson & Pipoly. Finally, the lectotypification status is discussed for **M. lanceolata** Pancher & Sébert.

RESUMEN

Se transfieren cincuenta y cinco taxa anteriormente referidos al género *Rapanea* Aubl. provenientes de la isla de Nueva Caledonia al género *Myrsine* L. Se proponen treinta y ocho nuevas combinaciones, listadas a continucación: **M. albiflorens** (M. Schmid) Ricketson & Pipoly; **M. arborea** (M. Schmid) Ricketson & Pipoly; **M. asymmetrica** (Mez) Ricketson & Pipoly; **M. belepensis** (M. Schmid) Ricketson & Pipoly; **M. boulindaensis** (M. Schmid) Ricketson & Pipoly; **M. citrifolia** (Mez) Ricketson & Pipoly; **M. diminuta** (Mez) Ricketson & Pipoly; **M. discocarpa** (M. Schmid) Ricketson & Pipoly; **M. dumbeaensis** (M. Schmid) Ricketson & Pipoly; **M. grandifolia** (S. Moore) Ricketson & Pipoly; **M. humboldtensis** (M. Schmid) Ricketson & Pipoly; **M. katrikouensis** (M. Schmid) Ricketson & Pipoly; **M. koghiensis** (M. Schmid) Ricketson & Pipoly; **M. kuebiniensis** (M. Schmid) Ricketson & Pipoly; **M. lecardii** (Mez), Ricketson & Pipoly; **M. macrophylla** (Mez) Ricketson & Pipoly; **M. mcphersonii** (M. Schmid) Ricketson & Pipoly; **M. memaoyaensis** (M. Schmid) Ricketson & Pipoly; **M. modesta** (Mez) Ricketson & Pipoly; **M. munzingeri** (M. Schmid) Ricketson & Pipoly; **M. nigricans** (M. Schmid) Ricketson & Pipoly; **M. nitens** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly; **M. oblanceolata** (M. Schmid) Ricketson

J. Bot. Res. Inst. Texas 4(2): 627 – 632. 2010

& Pipoly; **M. obovalifolia** (M. Schmid) Ricketson & Pipoly; **M. ouameniensis** (M. Schmid) Ricketson & Pipoly; **M. ouazangouensis** (M. Schmid) Ricketson & Pipoly; **M. ovicarpa** (M. Schmid) Ricketson & Pipoly; **M. paniensis** (M. Schmid) Ricketson & Pipoly; **M. parvicarpa** (M. Schmid) Ricketson & Pipoly; **M. poumensis** (M. Schmid) Ricketson & Pipoly; **M. pronyensis** (Guillaumin) Ricketson & Pipoly; **M. spissifolia** (M. Schmid) Ricketson & Pipoly; **M. stenophylla** (Mez) Ricketson & Pipoly; **M. taomensis** (M. Schmid) Ricketson & Pipoly; **M. tchingouensis** (M. Schmid) Ricketson & Pipoly; **M. verrucosa** (M. Schmid) Ricketson & Pipoly; **M. yateensis** (M. Schmid) Ricketson & Pipoly. Se proponen nuevas combinaciones y cambios del estatus donde se elevan dieciseis variedades y una forma, hasta el nivel de subespecie, mientras que se las transfieren al género *Myrsine*; incluyendo las siguientes: **M. asymmetrica** (Mez) Ricketson & Pipoly subsp. **magnifolia** (M. Schmid) Ricketson & Pipoly; **M. asymmetrica** (Mez) Ricketson & Pipoly subsp. **paniensis** (M. Schmid) Ricketson & Pipoly; **M. asymmetrica** (Mez) Ricketson & Pipoly subsp. **parvifolia** (M. Schmid) Ricketson & Pipoly; **M. lanceolata** Pancher & Sébert subsp. **ouenarouensis** (M. Schmid) Ricketson & Pipoly; **M. macrophylla** (Mez) Ricketson & Pipoly subsp. **menaziensis** (M. Schmid) Ricketson & Pipoly; **M. modesta** (Mez) Ricketson & Pipoly subsp. **coriaria** (M. Schmid) Ricketson & Pipoly; **M. modesta** (Mez) Ricketson & Pipoly subsp. **tiebaghiensis** (M. Schmid) Ricketson & Pipoly; **M. nigricans** (M. Schmid) Ricketson & Pipoly subsp. **ouinensis** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly subsp. **balabioensis** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly subsp. **boulindaensis** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly subsp. **kaalaensis** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly subsp. **mueoensis** (M. Schmid) Ricketson & Pipoly; **M. novocaledonica** (Mez) Ricketson & Pipoly subsp. **piroguensis** (M. Schmid) Ricketson & Pipoly; **M. oblanceolata** (M. Schmid) Ricketson & Pipoly subsp. **doensis** (M. Schmid) Ricketson & Pipoly; **M. parvicarpa** (M. Schmid) Ricketson & Pipoly subsp. **amossensis** (M. Schmid) Ricketson & Pipoly; **M. parvicarpa** (M. Schmid) Ricketson & Pipoly subsp. **pachyphylla** (M. Schmid) Ricketson & Pipoly; **M. verrucosa** (M. Schmid) Ricketson & Pipoly subsp. **microphylla** (M. Schmid) Ricketson & Pipoly. Se lectotipifican tres bionomiales: **M. citrifolia** (Mez) Ricketson & Pipoly; **M. lecardii** (Mez), Ricketson & Pipoly; **M. stenophylla** (Mez) Ricketson & Pipoly. Además, se discute la polémica lectotipificación para **M. lanceolata** Pancher & Sébert que todavía no tiene resolución definitiva.

INTRODUCTION

The relationship among *Myrsine* L. and its satellites (inter alia *Rapanea* Aubl. and *Suttonia* A. Rich.) has been a historical focal point for taxonomic contention that has resulted in the treatment of many species as *Rapanea* by regional floristicians, while monographers have determined that the variation in androecial structure among staminate flowers, and in gynoecial structure among the pistillate, supports the more broadly defined, monophyletic concept of *Myrsine*. Regional monographers recognizing the more inclusive concept include Hosaka (1940), Backer & Bakhuizen van den Brink (1965), Smith (1973), Fosberg & Sachet (1975, 1980), Sachet (1975), Li (1978), Wagner et al. (1990), Pipoly & Chen (1995), Pipoly (1996, 2007), Jackes (2005) and Takeuchi and Pipoly (2009) Among all of these papers, the most detailed treatment discussing all sides of the issue is provided by Pipoly (1996) in treating *Myrsine* of the Philippines. Given all the reasons cited in the aforementioned papers, we find that the recent new taxa and combinations made in *Rapanea* from New Caledonia by M. Schmid (2009), need to be transferred to *Myrsine*, to provide a consistent treatment of the genus pantropically, and necessitating the following new combinations:

Myrsine albiflorens (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea albiflorens* M. Schmid, Adansonia, sér. 3, 31:362. 2009. TYPE: NEW CALEDONIA: Koné, Creek Pandanus, 21°02'04"S, 164°46'31"E, 27 Jul 2006 (fl), *J. Munzinger & I. Spir 3513* (HOLOTYPE: P; ISOTYPES: MO, NOU).

Myrsine arborea (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea arborea* M. Schmid, Adansonia, sér. 3, 31:382, fig. 12A–D. 2009. TYPE: NEW CALEDONIA: Haute vallée de l'Amoa, ca. 400 m, 12 Aug 1965 (stam. fl), *H. MacKee 13241* (HOLOTYPE: P).

Myrsine asymmetrica (Mez) Ricketson & Pipoly, comb. nov. *Rapanea asymmetrica* Mez, Pflanzenr. IV. 236(Heft 9):366, fig. 61. 1902. TYPE: NEW CALEDONIA: Prony, Sep 1868 (fr), *B. Balansa 396* (LECTOTYPE: P [designated by Schmid 2009]; ISOLECTOTYPES: P [2]).

Myrsine asymmetrica (Mez) Ricketson & Pipoly subsp. **magnifolia** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea asymmetrica* Mez f. *magnifolia* M. Schmid, Adansonia, sér. 3, 31:348. 2009. TYPE: NEW CALEDONIA: Sin. loc., Exposition Universelle, 1889 (fr), *sine Coll. 62* (HOLOTYPE: P; ISOTYPE: P).

Myrsine asymmetrica (Mez) Ricketson & Pipoly subsp. **paniensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea asymmetrica* Mez var. *paniensis* M. Schmid, Adansonia, sér. 3, 31:350. 2009. TYPE: NEW CALEDONIA: Panié, 1200 m, 08 Apr 2006 (fr), *J. Munzinger, Y. Pillon, H. Blaffart, M. Wanguene & I. Spir 3468* (HOLOTYPE: P; ISOTYPES: MO, NOU).

Myrsine asymmetrica (Mez) Ricketson & Pipoly subsp. **parvifolia** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea asymmetrica* Mez var. *parvifolia* M. Schmid, Adansonia, sér. 3, 31:350, fig. 2C–F. 2009. TYPE: NEW CALEDONIA: Creek Pernod, ca. 180 m, 10 Oct 1987 (fr), *H. MacKee 43737* (HOLOTYPE: P).

Myrsine belepensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea belepensis* M. Schmid, Adansonia, sér. 3, 31:356, fig. 3C–D. 2009. TYPE: NEW CALEDONIA: Île Art, 21 Jun 1871 (fr), *B. Balansa 3363* (HOLOTYPE: P).

Myrsine boulindaensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea boulindaensis* M. Schmid, Adansonia, sér. 3, 31:361. 2009. TYPE: NEW CALEDONIA: Massif ultramafique du Boulinda, ca. 800 m, 26 Jul 1967 (fr), *H. MacKee 17207* (HOLOTYPE: P).

Myrsine citrifolia (Mez) Ricketson & Pipoly, comb. nov. *Rapanea citrifolia* Mez, Pflanzenr. IV. 236(Heft 9): 368. 1902. TYPE: NEW CALEDONIA: À la base des Koghis, 1870 (fr), *J. Pancher s.n., Mus. néo. cal. 302 bis* (LECTOTYPE: P (P00537891), [designated here]; ISOLECTOTYPES: L, P [2]).

Note.—Schmid (2009: 391) listed the *"Pancher, Mus. néo. cal. 302 bis"* collection from P as a holotype. However, Mez (1902: 368) in his original description clearly cited a *Pancher s.n.* collection from "herb. Mez, Paris." His personal collection was presumably lost at B in 1943 (Hiepko 1987), or at the Königsberg University herbarium in Sep. 1944 (Stafleu & Cowan 1981: 451), and thus the P and L sheets are the only material available. We designate the P sheet [P00537891] as a lectotype.

Myrsine diminuta (Mez) Ricketson & Pipoly, comb. nov. *Rapanea diminuta* Mez, Pflanzenr. IV. 236(Heft 9):366. 1902. TYPE: NEW CALEDONIA: Sommet du Mont Mou, ca. 1200 m, 13 Apr 1870 (fl, fr), *B. Balansa 2828* (LECTOTYPE: P [designated by Schmid 2009]; ISOLECTOTYPE: P).

Myrsine discocarpa (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea discocarpa* M. Schmid, Adansonia, sér. 3, 31:366, figs. 1D, 4A–C. 2009. TYPE: NEW CALEDONIA: Oué Djiaoumam région de Bourail, ca. 100 m, 24 Apr 1970 (fr), *H. MacKee 21843* (HOLOTYPE: P).

Myrsine dumbeaensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea dumbeaensis* M. Schmid, Adansonia, sér. 3, 31:356, figs. 1C, 3E–F. 2009. TYPE: NEW CALEDONIA: Bassin de la Dumbéa, ca. 50 m, 30 Jul 1984 (fr), *H. MacKee 42081* (HOLOTYPE: P).

Myrsine grandifolia (S. Moore) Ricketson & Pipoly, comb. nov. *Rapanea grandifolia* S. Moore, J. Linn. Soc., Bot. 45(303):350. 1921. TYPE: NEW CALEDONIA: Montagnes au nord de la Ngoye, sur serpentines, 1914 (pist. fl), *S. Compton 2065* (HOLOTYPE: K).

Myrsine humboldtensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea humboldtensis* M. Schmid, Adansonia, sér. 3, 31:372, fig. 9A–D. 2009. TYPE: NEW CALEDONIA: Mont Humboldt, ca. 1500-1600 m, 23 Sep 1951 (fr), *C. Baumann 15498* (HOLOTYPE: P).

Myrsine katrikouensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea katrikouensis* M. Schmid, Adansonia, sér. 3, 31:390, fig. 8E–G. 2009. TYPE: NEW CALEDONIA: Haute Kouaou, Katrikouen, ca. 600 m, 27 May 1983 (fr), *H. MacKee 41514* (HOLOTYPE: P).

Myrsine koghiensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea koghiensis* M. Schmid, Adansonia, sér. 3, 31:385, Fig. 5A–B. 2009. TYPE: NEW CALEDONIA: Mont Moné, Koghis, ca. 700 m, 27 Jul 1951 (fr), *M. Baumann-Bodenheim 14855* (HOLOTYPE: P).

Myrsine kuebiniensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea kuebiniensis* M. Schmid, Adansonia, sér. 3, 31:366. 2009. TYPE: NEW CALEDONIA: Basse Kuébini, ca. 5 m, 26 Nov 1979 (fr), *H. MacKee 37643* (HOLOTYPE: P).

Myrsine lanceolata Pancher & Sebert, Not. Bois. Nouvel. Caledon. 192. 1874. *Rapanea lanceolata* (Pancher & Sebert) Mez, Pflanzenr. IV. 236(Heft 9): 368. 1902. TYPE: NEW CALEDONIA: Sin. loc., 1861 (fl.), *Deplanche 24* (LECTOTYPE: P [designated by Schmid 2009]).

Note.—Schmid (2009: 386) selected the *Deplanche 24* collection as a lectotype for this taxon. However, Pancher and Sébert in Sébert (1874: 192–193) did not list any specific material in their original description. In Mez's (1902: 368–369) discussion for his new combination he lists two collections (*Deplanche 24* and *Pancher 35*) from P and BM. We can presume that Pancher and Sébert did have access to the *Pancher 35* collection; however, we cannot be certain if either collection was seen or used by them for their description. Although, we disagree with the selection of the *Deplanche 24* material as a lectotype, unfortunately at this time we are unable to locate a collection of *Pancher 35* and elect to defer correction of the lectotype at this time.

Myrsine lanceolata Pancher & Sebert subsp. **ouenarouensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea lanceolata* (Pancher & Sebert) Mez var. *ouenarouensis* M. Schmid, Adansonia, sér. 3, 31:387. 2009. TYPE: NEW CALEDONIA: Haute rivière des Pirogues, Ouénarou, ca. 150 m, 29 Aug 1987 (pist. fl), *H. MacKee 43666* (HOLOTYPE: P).

Myrsine lecardii (Mez) Ricketson & Pipoly, comb. nov. *Rapanea lecardii* Mez, Pflanzenr. IV. 236(Heft 9):369. 1902. TYPE: NEW CALEDONIA: Sin. loc., 25 Sep 1876 (fr), *Lécard s.n., Herb. de L'Exposition Colonial No.39 A53* (LECTOTYPE: P (P00537898), [designated here]).

Note.—Schmid (2009: 356) listed the *Lécard 53* [sheet is listed as *Lécard 39 A53*] collection from P as a holotype. However, Mez (1902: 369) in his original description clearly cited a *Lécard s.n.* collection from "herb. Mez, Paris." His personal collection was presumably lost at B in 1943 (Hiepko 1987), or at the Königsberg University herbarium in Sep. 1944 (Stafleu & Cowan 1981: 451), and thus the P sheet is the only material available. We designate the P sheet [P00537898] as a lectotype.

Myrsine macrophylla (Mez) Ricketson & Pipoly, comb. nov. *Rapanea macrophylla* Mez, Pflanzenr. IV. 236(Heft 9):369. 1902. Type: NEW CALEDONIA: Collines ferrugineuses à l'ouest de St. Louis, Dec 1868 (fr), *B. Balansa 992* (lectotype: P [designated by Schmid 2009]).

Myrsine macrophylla (Mez) Ricketson & Pipoly subsp. **menaziensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea macrophylla* Mez var. *menaziensis* M. Schmid, Adansonia, sér. 3, 31:388. 2009. Type: NEW CALEDONIA: Massif du Menazi, ca. 800 m, 12 Sep 1993 (fr), *T. Jaffré* 3233 (holotype: P).

Myrsine mcphersonii (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea mcphersonii* M. Schmid, Adansonia, sér. 3, 31:366, fig. 5C–D. 2009. Type: NEW CALEDONIA: Sud: Mont Humboldt, 21°53'S, 166°25'E, ca. 1600 m, 19 Sep 1980 (fl), *G. McPherson 3112* (holotype: P; isotype: MO).

Myrsine memaoyaensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea memaoyaensis* M. Schmid, Adansonia, sér. 3, 31:382, fig. 10E–H. 2009. Type: NEW CALEDONIA: Me Maoya, contrefort au sud de Djiaouma, ca. 1150 m, 11 Feb 1970 (fr), *H. MacKee 21522* (holotype: P).

Myrsine modesta (Mez) Ricketson & Pipoly, comb. nov. *Rapanea modesta* Mez, Pflanzenr. IV. 236(Heft 9):367. 1902. Type: NEW CALEDONIA: Au nord-est de la Conception, ca. 700 m, 07 Jan 1869 (fr), *B. Balansa 991* (lectotype: P [designated by Schmid 2009]).

Myrsine modesta (Mez) Ricketson & Pipoly subsp. **coriaria** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea modesta* Mez var. *coriaria* M. Schmid, Adansonia, sér. 3, 31:360. 2009. Type: NEW CALEDONIA: Mont Do, ca. 1000 m, 13 Aug 1974 (fl, fr), *H. MacKee 29119* (holotype: P).

Myrsine modesta (Mez) Ricketson & Pipoly subsp. **tiebaghiensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea modesta* Mez var. *tiebaghiensis* M. Schmid, Adansonia, sér. 3, 31:361. 2009. Type: NEW CALEDONIA: Partie haute du massif de la Tiébaghi, ca. 500 m, 17 Oct 1969 (fr), *H. MacKee 21016* (holotype: P).

Myrsine munzingeri (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea munzingeri* M. Schmid, Adansonia, sér. 3, 31:374, fig. 9E–G. 2009. Type: NEW CALEDONIA: Massif du Kouakoué, ca. 1250 m, 26 Nov 2002 (fr), *J. Munzinger 1668* (holotype: P).

Myrsine nigricans (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea nigricans* M. Schmid, Adansonia, sér. 3, 31:362, fig. 4D–J. 2009. Type: NEW CALEDONIA: Mandjélia, partie septentrionale de la chaîne du Panié - Ignambi, ca. 750 m, s.d. (pist. fl), *H. MacKee 40580* (holotype: P; isotype: MO).

Myrsine nigricans (M. Schmid) Ricketson & Pipoly subsp. **ouinensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea nigricans* M. Schmid var. *ouinensis* M. Schmid, Adansonia, sér. 3, 31:364, fig. 4J. 2009. Type: NEW CALEDONIA: Mont Quin, contrefort méridional du massif ultramafique du Humboldt, ca. 1100 m, 11 Aug 1974 (fl, fr), *H. MacKee 29079* (holotype: P; isotype: MO).

Myrsine nitens (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea nitens* M. Schmid, Adansonia, sér. 3, 31:370, figs. 1G, 8A–D. 2009. Type: NEW CALEDONIA: Ouazangou, 100-600 m, 19 Jun 1967 (fl, fr), *H. MacKee 16929* (holotype: P; isotype: MO).

Myrsine novocaledonica (Mez) Ricketson & Pipoly, comb. nov. *Rapanea novocaledonica* Mez, Pflanzenr. IV. 236(Heft 9):368. 1902. Type: NEW CALEDONIA: bosque des environs de Eammia, Environs de Nouméa, Feb 1871 (fl, fr), *B. Balansa 3362* (lectotype: P [designated by Schmid 2009]; isolectotypes: L, NY, P [2]).

Myrsine novocaledonica (Mez) Ricketson & Pipoly subsp. **balabioensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea novocaledonica* Mez var. *balabioensis* M. Schmid, Adansonia, sér. 3, 31:356. 2009. Type: NEW CALEDONIA: Île Balabio, baie du Capitaine, 10-150 m, 17 Sep 1974 (fr), *H. MacKee 29314* (holotype: P).

Myrsine novocaledonica (Mez) Ricketson & Pipoly subsp. **boulindaensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea novocaledonica* Mez var. *boulindaensis* M. Schmid, Adansonia, sér. 3, 31:354. 2009. Type: NEW CALEDONIA: Nord: Poya Commune, Poya, mine Saint-Louis, ca. 20 m, 07 Sep 1969, *H. MacKee 20693* (holotype: P).

Myrsine novocaledonica (Mez) Ricketson & Pipoly subsp. **kaalaensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea novocaledonica* Mez var. *kaalaensis* M. Schmid, Adansonia, sér. 3, 31:354. 2009. Type: NEW CALEDONIA: Sommet du mont Kaala, 1050 m, 09 Jul 1966 (fr), *H. MacKee 15278* (holotype: P).

Myrsine novocaledonica (Mez) Ricketson & Pipoly subsp. **mueoensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea novocaledonica* Mez var. *mueoensis* M. Schmid, Adansonia, sér. 3, 31:354. 2009. Type: NEW CALEDONIA: Muéo, mine Oubliée, ca. 200 m, 18 Aug 1984 (fr), *H. MacKee 42184* (holotype: P).

Myrsine novocaledonica (Mez) Ricketson & Pipoly subsp. **piroguensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea novocaledonica* Mez var. *piroguensis* M. Schmid, Adansonia, sér. 3, 31:354. 2009. Type: NEW CALEDONIA: Baie des Pirogues, 15 Apr 1967 (fl, fr), *H. MacKee 16575* (holotype: P).

Myrsine oblanceolata (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea oblanceolata* M. Schmid, Adansonia, sér. 3, 31:388, fig. 13E–I. 2009. Type: NEW CALEDONIA: Baie de Prony, Sep 1868 (pist. fl), *B. Balansa 397* (holotype: P; isotypes: P [2]).

Myrsine oblanceolata (M. Schmid) Ricketson & Pipoly subsp. **doensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea oblanceolata* M. Schmid var. *doensis* M. Schmid, Adansonia, sér. 3, 31:390. 2009. TYPE: NEW CALEDONIA: Mont Do, ca. 950 m, 28 Jul 1999 (pist. fl), *T. Jaffré 3383* (HOLOTYPE: P; ISOTYPES: NOU, MO).

Myrsine obovalifolia (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea obovalifolia* M. Schmid, Adansonia, sér. 3, 31:362. 2009. TYPE: NEW CALEDONIA: Nord: Mont Panié, 20°36'S, 164°46'E, ca. 1450 m, 13 Jan 1981 (fr), *G. McPherson 3545* (HOLOTYPE: P; ISOTYPE: MO).

Myrsine ouameniensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea ouameniensis* M. Schmid, Adansonia, sér. 3, 31:394, fig. 14A–C. 2009. TYPE: NEW CALEDONIA: Vallée de la Ouaménie, 02 Sep 2006 (pist. fl), *J. Munzinger, D. Létocart, I. Létocart, R. Amice & Gateble 3534* (HOLOTYPE: P; ISOTYPES: MO, NOU).

Myrsine ouazangouensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea ouazangouensis* M. Schmid, Adansonia, sér. 3, 31:364, fig. 4K–M. 2009. TYPE: NEW CALEDONIA: Massif ultramafique du Ouazangou-Taom, ca. 1000 m, 31 Jul 1981 (fl, fr), *H. MacKee 39397* (HOLOTYPE: P; ISOTYPE: MO).

Myrsine ovicarpa (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea ovicarpa* M. Schmid, Adansonia, sér. 3, 31:391, figs. 1K, 7F–I. 2009. TYPE: NEW CALEDONIA: Kouébini, zone côtière au sud-est de la Grande Terre, ca. 5 m, 26 Nov 1979 (fr), *H. MacKee 37647* (HOLOTYPE: P).

Myrsine paniensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea paniensis* M. Schmid, Adansonia, sér. 3, 31:384, fig. 11E–H. 2009. TYPE: NEW CALEDONIA: Mont Panié, versant oriental, ca. 1000 m, 14 Oct 1967 (pist. fl), *M. Schmid 4150* (HOLOTYPE: P; ISOTYPE: NOU).

Myrsine parvicarpa (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea parvicarpa* M. Schmid, Adansonia, sér. 3, 31:377, figs. 1H, 10A–D. 2009. TYPE: NEW CALEDONIA: Col des Roussettes, ca. 500 m, 23 Sep 1965 (stam. fl), *H. MacKee 13446A* (HOLOTYPE: P; ISOTYPE: P).

Myrsine parvicarpa (M. Schmid) Ricketson & Pipoly subsp. **amossensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea parvicarpa* M. Schmid var. *amossensis* M. Schmid, Adansonia, sér. 3, 31:378. 2009. TYPE: NEW CALEDONIA: Col d'Amoss, ca. 450 m, 13 Nov 2002 (fr), *J. Munzinger et al. 1476* (HOLOTYPE: P; ISOTYPE: NOU).

Myrsine parvicarpa (M. Schmid) Ricketson & Pipoly subsp. **pachyphylla** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea parvicarpa* M. Schmid var. *pachyphylla* M. Schmid, Adansonia, sér. 3, 31:378, fig. 11A–D. 2009. TYPE: NEW CALEDONIA: Sud: Mont Kouakoué, 21°59'02"S, 166°32'10"E, ca. 1100 m, 06 Nov 2004 (fr), *J. Labat, J. Munzinger & G. McPherson 3466* (HOLOTYPE: P; ISOTYPES: MO, NOU).

Myrsine poumensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea poumensis* M. Schmid, Adansonia, sér. 3, 31:392, fig. 14D–E. 2009. TYPE: NEW CALEDONIA: Massif de Poum, ca. 350 m, 10 Sep 1969 (stam. fl), *H. MacKee 20780* (HOLOTYPE: P).

Myrsine pronyensis (Guillaumin) Ricketson & Pipoly, comb. nov. *Rapanea pronyensis* Guillaumin, Bull. Soc. Bot. France. Sér. 5, 88(2-6):397. 1941. TYPE: NEW CALEDONIA: Baie de Prony, Sep 1868 (fl), *B. Balansa 398* (HOLOTYPE: P).

Myrsine spissifolia (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea spissifolia* M. Schmid, Adansonia, sér. 3, 31:383. 2009. TYPE: NEW CALEDONIA: Mont Paéoua, 800-1100 m, 14 Oct 1967 (fl, fr), *H. MacKee 17702* (HOLOTYPE: P; ISOTYPE: MO).

Myrsine stenophylla (Mez) Ricketson & Pipoly, comb. nov. *Rapanea stenophylla* Mez, Pflanzenr. IV. 236(Heft 9):370. 1902. TYPE: NEW CALEDONIA: Berges de la Néoua, entre Bourail et Kouaoua, 18 Mar 1869 (fl), *B. Balansa 990* (LECTOTYPE: P (P00537927), [designated here]; ISOLECTOTYPES: P [2]).

Note.—Schmid (2009: 357) listed the *B. Balansa 990* collection from P as a holotype. However, Mez (1902: 370) in his original description clearly cited the *B. Balansa 990* collection from "herb. Mez, Paris." His personal collection was presumably lost at B in 1943 (Hiepko 1987), or at the Königsberg University herbarium in Sep. 1944 (Stafleu & Cowan 1981: 451), and thus the P sheets are the only material available. We here designate the P sheet [P00537927] as a lectotype.

Myrsine taomensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea taomensis* M. Schmid, Adansonia, sér. 3, 31:384, fig. 12E–G. 2009. TYPE: NEW CALEDONIA: Mont Taom, ca. 1000 m, (fl, fr), *H. MacKee 37162* (HOLOTYPE: P).

Myrsine tchingouensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea tchingouensis* M. Schmid, Adansonia, sér. 3, 31:374, fig. 9H–I. 2009. TYPE: NEW CALEDONIA: Nord: Massif du Tchingou, 20°53'56"S, 165°00'27"E, 1260 m, 04 Apr 2001 (fr), *J. Munzinger & G. McPherson 669* (HOLOTYPE: P; ISOTYPES: MO, NOU).

Myrsine verrucosa (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea verrucosa* M. Schmid, Adansonia, sér. 3, 31:368, figs. 1E, 6A–D. 2009. TYPE: NEW CALEDONIA: Koniambo, 400–700 m, 21 May 1967 (fr), *H. MacKee 16775* (HOLOTYPE: P).

Myrsine verrucosa (M. Schmid) Ricketson & Pipoly subsp. **microphylla** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov. *Rapanea verrucosa* M. Schmid var. *microphylla* M. Schmid, Adansonia, sér. 3, 31:370, fig. 6E–F. 2009. TYPE: NEW CALEDONIA: Montagne au sud de Thio, ca. 600 m, 07 Aug 1966 (fr), *H. MacKee 15466* (HOLOTYPE: P).

Myrsine yateensis (M. Schmid) Ricketson & Pipoly, comb. nov. *Rapanea yateensis* M. Schmid, Adansonia, sér. 3, 31:370, figs. 1F, 7A–E. 2009. TYPE: NEW CALEDONIA: Gouemba, au dessus de Yaté, ca. 300 m, 04 Jun 1977 (fr), *H. MacKee 33347* (HOLOTYPE: P).

REFERENCES

BACKER, C.A. AND R.C. BAKHUIZEN VAN DEN BRINK JR. 1965. Myrsinaceae. In: Flora of Java (Spermatophytes only). P. Noordhoff, Groningen. 2:194–203.

FOSBERG, F.R. AND M.-H. SACHET. 1975. Polynesian plant studies 1-5, 2: *Myrsine* L. in Eastern Polynesia. Smithsonian Contr. Bot. 21:1–25.

FOSBERG, F.R. AND M.-H. SACHET. 1980. Systematic studies of Micronesian plants. Smithsonian Contr. Bot. 45:1–40.

HIEPKO, P. 1987. The collections of the Botanical Museum Berlin-Dahlem (B) and their history. Englera 7:219–252.

HOSAKA, E.Y. 1940. A revision of the Hawaiian species of Myrsine (Suttonia, Rapanea) (Myrsinaceae). Occas. Pap. Bernice P. Bishop Mus. 16(2):25–76.

JACKES, B.R. 2005. Revision of Myrsine (Myrsinaceae) in Australia. Austral. Syst. Bot. 18:399–438.

LI, H.-L. 1978. Myrsinaceae. In: H.-L. Li, T.-S. Liu, T.-C. Huang, T. Koyama and C. Devol, eds. Flora of Taiwan. Epoch Publishing, Taipei. 4:47–67, pls. 909–913.

MEZ, C.C. 1902. Myrsinaceae. In: H.G.A. Engler, Das Pflanzenreich. Regni vegetabilis conspectus. Im Auftrage der Preuss. Akademie der Wissenschaften, herausgegeben von A. Engler. IV (Embryophyta siphonogama). Wilhelm Engelmann, Berlin. IV. 236(Heft 9):1–437.

PIPOLY III, J.J. 1996. Contributions toward a new flora of the Philippines: I. A synopsis of the genus Myrsine (Myrsinaceae). Sida 17:115–162.

PIPOLY III, J.J. 2007. Myrsinaceae of Papua. In: A. Marshall and B. Beehler, eds. The ecology of Papua Part One. The ecology of Indonesia Series, Vol. VI. Conservation International. Conservation International Periplus Editions (HK) Ltd., Hong Kong. 6(1):416–428.

PIPOLY III, J.J. AND C. CHEN. 1995. Nomenclatural notes on the Myrsinaceae of China. Novon 5:357–361.

SACHET, M.-H. 1975. Flora of Marquesas, 1: Ericaceae–Convolvulaceae. Smithsonian Contr. Bot. 23:1–34.

SCHMID, M. 2009. Contribution à la connaissance des Primulaceae (ex Myrsinaceae) de Nouvelle-Calédonie. II, Le genre Rapanea Aubl. Adansonia, sér. 3, 31:341–395.

SÉBERT, H. 1874. Myrsinées. In: Notice sur les Bois de la Nouvelle Calédonie Suivie de Considérations Générales sur les Propriétés Mécaniques des Bois et sur les Procédés Employés pour les Mesurer par H. Sébert capitaine d'artillerie de la marine. Partie descriptive en commun avec M. Pancher, ancien botaniste du gouvernement, d Nouméa. Arthus Bertrand, Paris. Pp.191–193.

SMITH, A.C. 1973. Studies of Pacific Island plants, XXV. The Myrsinaceae of the Fijian region. J. Arnold Arbor. 54:1–41.

STAFLEU, F.A. AND R.S. COWAN. 1981. Taxonomic literature. Volume 3, Lh–O: a selective guide to botanical publications and collections with dates, commentaries and types. Bohn, Scheltema & Holkema, Utrecht, dr. W. Junk b.v. Publishers, The Hague. 3:1–980.

TAKEUCHI, W.N. AND J.J. PIPOLY III. 2009. Nomenclatural transfers in East Malesian Myrsine (Myrsinaceae), and the description of *M. warrae*, a distinctive new species from ultrabasic environments in Papua New Guinea. Edinburgh J. Bot. 66:459–467.

WAGNER, W.L., D.R. HERBST, and S.H. SOHMER. 1990. Myrsinaceae. in Manual of the flowering plants of Hawai'i. Revised edition. University of Hawaii Press: Bishop Museum Press, Honolulu. 1: Pp. 931–947.

HEDYCHIUM FORRESTII (ZINGIBERACEAE) WITH A NEW SYNONYMY AND A VARIETY FROM INDIA

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ABSTRACT

Hedychium dekianum is reduced to a new synonym of *H. forrestii*. It is a new extended distributional record of the Chinese species for India. Yet, another new variety **H. forrestii** var. **palaniense** Sanoj & M. Sabu, var. nov. is described from Western Ghats, South India. Key to the varieties, detailed descriptions, illustrations, and relevant notes are also provided.

RESUMEN

Hedychium dekianum se reduce a un nuevo sinónimo de *H. forrestii*. Es una nueva cita que extiende la distribución de la especie china por la India. Además, se describe una nueva variedad **H. forrestii** var. **palaniense** Sanoj & M. Sabu, var. nov. de Western Ghats, South India. Se aporta una clave de variedades, descripciones detalladas, ilustraciones y notas relevantes.

INTRODUCTION

Hedychium, commonly called as "ginger lily" or "butterfly lily," produces one of the most beautiful and fragrant flowers in the family Zingiberaceae. Though the flowers are short lived, many flowers are produced in succession on an inflorescence for a longer period. The genus was established by Koenig in 1783, based on the species *H. coronarium* Koenig. It includes about 80 species and are mainly distributed in India, South China, and southeast Asia (Sirirugsa & Larsen 1995). This is the largest genus of the family in India with about 43 taxa, and are mainly distributed in northeastern states with 16 endemics (Jain & Prakash 1995), of which only 4 are represented in South India.

As part of a revision of *Hedychium* in India, the authors collected specimens of *H. dekianum* A.S. Rao & D.M. Verma on the way to Dauki from Jowai, (near to the type locality) Meghalaya. This taxon was compared with the closely related taxa like *H. coronarium*, *H. forrestii*, *H. stenopetalum*, and *H. larsenii*. Detailed studies have revealed that it is conspecific with *H. forrestii*. Since *H. forrestii* has priority over *H. dekianum*, the latter is reduced as a synonym of *H. forrestii*.

Subsequently, we could collect an interesting specimen from Palani hills of South India which differs from other South Indian taxa. The authors also observed one collection of the above taxon at MH and two at E, from the same locality. On comparison with *H. forresti*, it is turned out to be a new variety and is described here as *H. forrestii* var. *palaniense*. *Hedychium forrestii* var. *latebracteatum* Larsen is the another variety described by Larsen (1965) on the basis of a Tonkin collection from Vietnam (*Poilane 12791* P, image !) with a relatively condensed spike and apically truncate bracts. He distinguished it from the type species in "*bracteis latis, apice rotundate obtusis, axem dense congestis plane obtegentibus, floribus flavis*." This taxon is excluded in this paper due to lack of sufficient data and its distribution is restricted to only Vietnam. But a key to the varieties of *H. forrestii*, including *H. forrestii* var. *latebracteatum* is also provided.

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TAXONOMIC TREATMENT

KEY TO THE VARIETIES OF *HEDYCHIUM FORRESTII*

1. Flowers yellow ____ var. **latebracteatum**
1. Flowers white.
   2. Flower 15–15.2 cm long; corolla tube 9.2–9.4 cm long; calyx equal or slightly longer than bracts ____ var. **palaniense**
   2. Flower10–12.2 cm long; corolla tube 5–7.1 cm long; calyx shorter than bracts ____ var. **forrestii**

1. Hedychium forrestii var. **palaniense** Sanoj & M. Sabu, var. nov. (**Figs. 1, 2D**). TYPE: INDIA. TAMIL NADU. Dindigul Dt.: Perumal Malai, Palani Hills, on the way to Kodaikanal from Palani, 1380 m, 20 Aug 2005, *E. Sanoj 86151* (HOLOTYPE: CALI, ISOTYPE: CAL, MH).

A varietate typica floribus et corollae tubo longioribus (9.2–9.4 mm), calycibus bracteis aequilongis vel parum longioribus differt.

Perennial rhizomatous herbs. **Rhizome** 2.7–3 cm wide, creamy yellow internally, slightly aromatic. **Leafy shoot** 108–110 cm high, erect, robust. **Leaves** 10–13 in number, spreading, sessile; sheath margins white, membranous, translucent, sparsely pubescent; ligule 4–4.7 × ca. 2 cm, ovate, single lobed, white, pubescent externally, glabrous towards margins, membranous, translucent, papery, closely appressed with the stem; lamina 38.8–43 × 8.5–7.7 cm, elliptic, dark green and glabrous above, pale green and puberulent below, hairyness increases towards tip; margin undulate, membranous, translucent, white tinged, non-ciliate; tip long caudate, twisted; base cuneate; midrib pubescent below. **Inflorescence** 16.5–23.2 cm long, cylindrical, lax, erect. **Bracts** 4.5–4.7 × 1.8–2 cm, lanceolate, green, glabrous, pubescent towards tip, coriaceous, non-imbricating, convolute; margin non-ciliate, translucent, membranous, white; tip rounded, cincinnus ca. 3-flowered. **Bracteoles** 2.1–2.8 × 1.2–2 cm, outer one tubular, inner ones nontubular, translucent, slightly 2 or 3 lobed at tip, pale green, white towards base, glabrous, pubescent towards tip, leathery; margin ciliate at tip. **Flower** 15–15.2 cm long, white, 4–6 -flowers opens at a time, ascending, slightly fragrant. **Calyx** 4.8–5.1 cm long, 4.5–5 mm wide at mouth, pale green, pubescent externally, sparse towards base, membranous, translucent, upper half inflated, lower half closely appressed to corolla tube, unilaterally split upto 1.1–1.4 cm, 3-toothed at tip. **Corolla tube** 9.2–9.4 cm long, ca. 4 mm wide at mouth, white, glabrous externally, downwardly directed hairy internally, glabrous towards base, bend to one side at centre. **Corolla lobes** oblong, white, pale greenish yellow tinged towards tip, membranous, early decaying at base, drooping from flower, glabrous, margins rolled inside, slightly coiled like an expanded spring; dorsal lobe 4.8–5 cm × ca. 6.5 mm, 3.5–4 mm long beaked at tip, surface with small raised processes; lateral lobes 4.5–4.7 cm × ca. 6.5 mm, non-beaked at tip. **Lateral staminodes** 4.1–4.4 × 1.9–2 cm, elliptic, white, spreading on flower, reflexed back, margin undulate. **Labellum** 4.3–4.6 × 4–4.2 cm, widely depressed ovate, white, pale yellow tinge at centre and towards base, spreading on flower, reflexed back on upper half, base cordate, abruptly clawed at base; claw 6.5–7 mm wide; tip 1.9–2.1 cm deeply emarginated; margin undulate, lobes rounded at tip. **Stamen** 5.6–6 cm long, longer than labellum, bend at tip, white with orange anther openings. **Filament** 4.4–4.5 cm long, ca. 2 mm wide at base, white, bend to one side at tip. **Anther** 1.3–1.4 × ca. 3 cm, elliptic, split opens from top to bottom, attached with the filament at 2.5–3 mm above from base, thecae at an angle of ca. 45° with the filament axis; anther suture pale red; connective white, glabrous, non-crested, tip truncate. **Ovary** 4–4.5 × 3.5–4 mm, barrel-shaped, pale green, pubescent externally, trilocular, ovules many, placentation axile. **Style** filiform, white, glabrous, pubescent towards tip, broadens and yellowish-green tinged towards stigma. **Stigma** ca. 2.5 mm wide, yellowish-green, cup-shaped, slanting with a depression at center, pubescent, hairs hook-like, bulbous based, ca. 1.5 mm exserted the anther. **Epigynous glands** two, 2.5–3 mm long, oblong, yellow. **Fruits** 3.5–4 × ca. 3 cm, loculicidal capsule, ovate, three-angled, glabrous, trilocular, surface smooth; fruit wall green externally, orange internally, completely split and reflexed back on dehiscence. **Seeds** ca. 4.5 × 3 mm, red, grey when dry, yellow at base, compactly arranged on column. **Aril** red, yellow when dry, lacerate, basal.

Notes.—*Hedychium forrestii* var. *palaniense* is allied to *H. forrestii*, but differs in having longer flower and corolla tube (9.2–9.4 cm) and calyx equal or slightly longer than bracts.

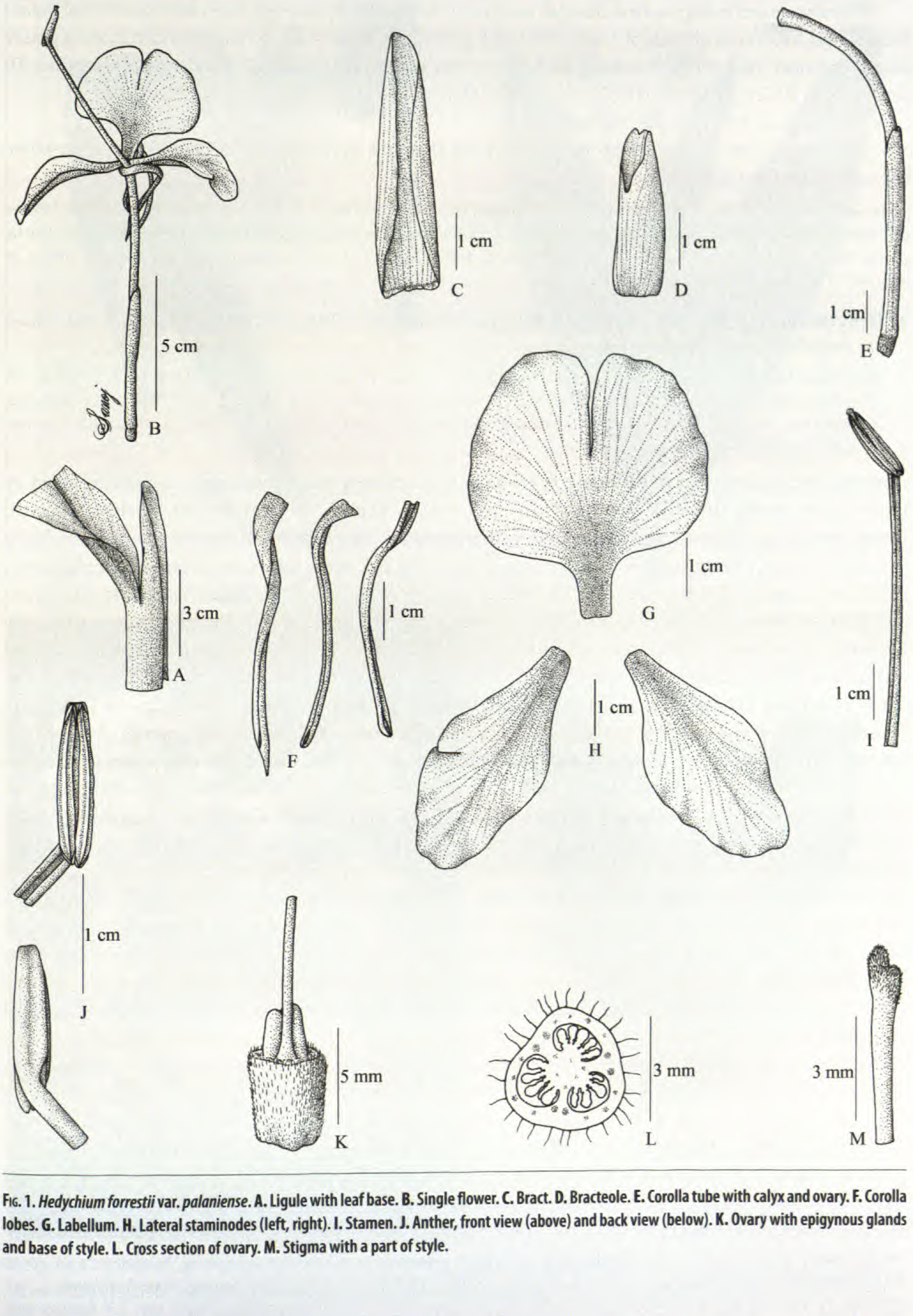

Fig. 1. ***Hedychium forrestii*** **var.** ***palaniense*****. A. Ligule with leaf base. B. Single flower. C. Bract. D. Bracteole. E. Corolla tube with calyx and ovary. F. Corolla lobes. G. Labellum. H. Lateral staminodes (left, right). I. Stamen. J. Anther, front view (above) and back view (below). K. Ovary with epigynous glands and base of style. L. Cross section of ovary. M. Stigma with a part of style.**

Distribution and ecology.—*Hedychium forrestii* var. *palaniense* is known only from four localities of Palani Hills, Tamil Nadu at an altitude of 1300 –1600 m. It grows as patches of 15–20 mature individuals in grassy slopes and open rock cliffs. It is assessed here as Critically Endangered (CR) (CRB1ab(i,ii)+ 2ab(i,ii); D) according to IUCN guidelines (IUCN 2001, IUCN Standards and Petitions Subcommittee 2010).

Flowering and fruiting.—July through October.

Etymology.—The varietal epithet has been derived from the type locality, i.e., 'Palani Hills', from where the variety has been described.

Additional specimens examined: **INDIA. Tamil Nadu. Nilgiris Dt.:** Kailas Pillai Estate to Sirur (near Ebanad), 6 Sep 1970, 1450 m, *G.V. Subba Rao 36524* (MH). **Dindigul Dt.:** Anna, Kodaikanal, Palani Ghat Road between Perumal Malai and Vadakavunchi, 1500 m, 23 Sep 1986, *K.M. Matthew, M. Charles & N. Rajendran 46992* (E), Palani Ghat Road, below Perumal Peak (Rajamani Estate), 1600 m, 26 Aug 1987, *K.M. Matthew & N. Rajendran 46992* (E).

2. Hedychium forrestii Diels, Notes Roy. Bot. Gard. Edinburgh 5:304. 1912. **(Fig. 2A)**. Type: CHINA. Yunnan: Dali valley, 25°40'N, *G. Forrest 4812* (E!).

Hedychium dekianum A.S. Rao & D.M. Verma, Bull. Bot. Surv. India 11(1&2):122. 1969 syn. nov.; 14(1–4):129. 1972; N.P. Balakr., Fl. Jowai Vicinity, Meghalaya 2:527. 1983; Karthik. et al., Fl. Indicae Enum. Monocot. 294. 1989. (Fig. 2B, C) Type: INDIA: Meghalaya, East Khasi Hills Dt.: Shillong, Woodlands (introduced from Khliehriat road from Jowai), 15 Jul 1966, *G.K. Deka 35605* (holotype: CAL!; isotype: ASSAM!).

Perennial rhizomatous herbs. **Rhizome** 3.3–3.6 cm wide, creamy white internally, aromatic, covered by brown scales. **Leafy shoot** 100–200 cm high, erect, robust. **Leaves** 12–18 in number, 12–16.2 cm apart, sessile, spreading; sheath ca. 3.5 cm wide, green, margins pink, membranous, translucent, pubescent; ligule 3–5.2 × 2–2.3 cm, oblong, single lobed, slightly notched at tip, pale green, sericeous externally, membranous, translucent, papery, closely appressed to the stem; lamina 34–55 × 6–13.3 cm, elliptic-lanceolate, dark green and glabrous above (pink tinged in lower leaves), pale green and appressed silky hairy below; margin highly undulate, membranous, translucent, pink tinged, non-ciliate, folded back; tip long caudate, twisted, bend down; base oblique; midrib pink tinged below towards base. **Inflorescence** 15–27.6 cm long, cylindrical, erect, moderately lax; peduncle green, pubescent. **Bracts** 4.8–5 × 2.5–2.7 cm, obovate, green, pubescent, dense towards tip and margins, leathery, convolute; margin non-ciliate, translucent, membranous, white; tip rounded; cincinnus 2–5 -flowered. **Bracteoles** 3–3.7 × 2.1–2.3 cm, ovate, green, pubescent, outer one tubular, inner ones non-tubular; margin membranous, translucent, non-ciliate. **Flower** 10–12.2 cm long, white, spreading, 10–13 flowers opens at a time, ascending, slightly fragrant. **Calyx** 4.2–4.3 cm long, shorter than bracts, 3.5–4 mm wide at mouth, white with pale yellow tinge, pubescent externally, membranous, translucent, upper half inflated, lower half closely appressed to corolla tube, unilaterally split upto 1.2–1.3 cm, 3-toothed at tip. **Corolla tube** 5–7.1 cm long, ca. 3.5 mm wide at mouth, white, glabrous externally, downwardly directed hairy internally, glabrous towards base, erect or slightly bend towards tip. **Corolla lobes** oblanceolate, white, pale green tinged towards tip, membranous, early decaying at base, drooping from flower, glabrous, margins rolled inside, slightly coiled like an expanded spring; dorsal lobe 4.7–4.8 × ca. 0.6 cm, 5–6 mm long beaked at tip; lateral lobes 4.2–4.3 × ca. 0.5 cm, non-beaked at tip. **Lateral staminodes** 3.4–3.7 × 0.8–1.4 cm, elliptic-oblanceolate, white, spreading on flower, reflexed back, tip obtuse, margin undulate. **Labellum** 3.5–3.8 × 3.1–3.5 cm, widely ovate-orbicular, white, pale yellow tinge at centre and claw, spreading on flower, reflexed back on upper half, abruptly clawed at base; claw 6–8 mm wide; tip 1.2–1.7 cm deeply emarginated; margin undulate; lobes tip obtuse. **Stamen** 5–5.5 cm long, longer than labellum. **Filament** 4–4.5 cm long, ca. 2 mm wide at base, white, erect. **Anther** 1.1–1.3 × ca. 0.25 cm, oblong, creamy white, split opens from top to bottom, attached with the filament at ca. 2.5 mm above from base, thecae parallel with the filament axis; connective white, glabrous, non-crested, slightly notched, tip truncate. **Ovary** 4.5–5 × 3–3.5 mm, barrel-shaped, pale green, densely pubescent, trilocular, ovules many, placentation axile. **Style** filiform, white, glabrous, pubescent towards tip, broadens and green tinged towards stigma. **Stigma** green, cup-shaped, slanting with a depression at center, densely pubescent, hairs hook-like, bulbous based, 1–1.5 mm exserted from the anther. **Epigynous glands** two, 3–3.5 mm long, oblong, bright yellow. **Fruits** 4–6 × ca. 1.5 cm, oblong-cylindrical.

Fig. 2. A. *Hedychium forrestii.* Type specimen (*G. Forrest 4812*), reproduced with kind permission from Botanic Garden Edinburgh. **B.** *Hedychium dekianum.* Type specimen (*G.K. Deka 35605*). **C.** *Hedychium forrestii* (*E. Sanoj & T. Rajesh Kumar 94905*), photo by E. Sanoj. **D.** *Hedychium forrestii* var. *palaniense.* Type specimen (*E. Sanoj 86151*).

Notes.—*Hedychium forrestii* was originally described by Diels in 1912, based on a collection by Forrest (holotype: *G. Forrest 4812*, E!) from Tali valley in Western Yunnan. He distinguished this species from *H. coronarium* Koenig by its "narrower spreading bracts, the narrower segments of the corolla and broader staminodes." However, he admitted that, he was not able to study some of the floral details of this species. Diels' diagnosis of this species was rather short and was based on a specimen with a single upper leaf and an inflorescence. Later, while describing the new variety from Vietnam (var. *latebracteatum*), Larsen (1965) elaborated on the description of *H. forrestii* based on his studies at Kew, Paris, and Edinburgh.

In the meanwhile, Rao and Verma (1969) apparently being unaware of the description of *H. forrestii*, described yet another species, *Hedychium dekianum* from Jowai, Assam (presently in Meghalaya), based on a collection by Deka (*G.K. Deka 35605 A*). The authors compared their new species with *H. coronarium* and distinguished it by its "lax spikes; closely convolute bracts; stamen exceeding the lip and oblong-cylindric capsule."

During the course of revision of the genus in India, we were able to collect and study a large number of specimens of *Hedychium* from the entire Northeast India. Our studies on *H. dekianum* based on the types and live specimens have indicated that Indian specimens differ from *H. forrestii* in the white color of the filament and creamy white anther, whereas it is salmon pink and crimson respectively in *H. forrestii*, which is mentioned only in one of the collections of *G. Forrest 8478* (K!). As the differences between these taxa are not sufficient to recognize them even as varieties, *H. dekianum* is reduced to a synonym of *H. forrestii*.

Distribution and ecology.—Distributed in Yunnan and Guizhou provinces of China, India, northern Thailand, Myanmar, and Vietnam. In India it is restricted to the districts, East Khasi Hills and Jaintia Hills of Meghalaya. It is a robust herbaceous plant growing in populations of 3–5 plants in open and moist forest lands.

Hedychium forrestii is facing a very high risk of extinction in the wild. Hence we categorize it as Endangered (EN) (CRB1ab(i,ii,iv)+ 2ab(i,ii,iv) as per IUCN guidelines (IUCN 2001, IUCN Standards and Petitions Subcommittee 2010).

Flowering and fruiting.—July through October

Additional specimens examined: **CHINA. Yunnan:** Hoching valley, 1910, 7000 ft, 26°30', *G. Forrest 6529* (E, K); Sen district, 1900–1922, *J. Cavalerie 7538* (E), *J. Cavalerie 3660* (E); Shweli valley, 5000 ft, 25° N, Jun 1912, *G. Forrest 8478* (K, E); Tengyueh valley, 25° N, 6000 ft, Jun 1912, *G. Forrest 8428* (E); near Tengyueh, 5500–6500 ft, Jul 1924, *G. Forrest 24761* (E, K); Lava land W of Tengyueh, 25° N, 5000 ft, Jul 1912, *G. Forrest 8686* (E). **INDIA.** Meghalaya. East Khasi Hills Dt.: Shillong, Woodlands, 20 Aug 1970, *D.M. Verma 34198* (ASSAM). Jaintia Hill Dt.: Khliehriat road from Jowai, 23 Oct 1967, *G.K. Deka 37306 A* (ASSAM); 5 mi before Jowai, 16 Aug 1968, *N.P. Balakrishnan 46119 B, D, 46934 E*, (ASSAM); Jowai-Jorain, 20 Aug 1968, *N.P. Balakrishnan 46882* (ASSAM); Way to Dauki from Jowai, N 25°09.769' E 092°23.383', 473 m, 16 Aug 2007, *E. Sanoj & T. Rajesh Kumar 94905* (CALI). **MYANMAR.** Maymyo Plateau, 3500 ft, Sep 1908, *J.H. Lack* (E).

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REFERENCES

Diels, L. 1912. Plantae Chinenses Forrestianae. Notes Royal Bot. Gard. Edinburgh 5:304.

Jain, S.K. and V. Prakash. 1995. Zingiberaceae in India: phytogeography and endemism. Rheedea 5:154–169.

Koenig, J.F. 1783. Observationes botanicae (Retzius) 3:73–74.

IUCN. 2001. IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge.

IUCN Standards and Petitions Subcommittee. 2010. Guidelines for Using the IUCN Red List Categories and Criteria. Version 8.0. Prepared by the Standards and Petitions Subcommittee in March 2010.

Larsen, K. 1965. Studies in Zingiberaceae V, *Hedychium*—Some new Indo-Chinese taxa. Bot. Tidsskr. 61:71–79.

Rao, A.S. and D.M. Verma. 1969. Notes on *Hedychium* Koenig, including four new species from Khsai and Jaintia Hills. Assam. Bull. Bot. Surv. India 11:120–128.

Sirirugsa, P. and K. Larsen. 1995. The genus *Hedychium* (Zingiberaceae) in Thailand. Nordic J. Bot. 15:301–304.

BOOK REVIEW

Toutcha Lebgue Keleng and Gustavo Quintana Martínez. 2010. **Cactáceas de Chihuahua: Tesoro estatal en peligro de extinción.** (ISBN 978-6-077-78834-8, pbk.). Published by the authors. (**Orders:** Contact Robert Armijo at: rarmijp@yahoo.com; accepting checks only). $25.00, 248 pp., color photos, b&w maps, 5⅜" × 8⅜".

This book, written in Spanish, begins with the general morphology of cacti and proceeds to a description, with color photos, of the various habitats or vegetational associations found in Chihuahua. This is followed by over 100 species descriptions arranged alphabetically by genus. Good color photos and dot maps are provided for each species. The plant descriptions are fairly thorough and include distribution not only in Chihuahua and elsewhere in Mexico but also states in the United States. Habitat and synonyms are also given. This publication should appeal to amateur and professionals alike looking for a guide to the cacti of the region.—*Robert J George, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

THE REINSTATEMENT OF *PTILIMNIUM TEXENSE* (APIACEAE) AND A NEW KEY TO THE GENUS

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ABSTRACT

Ptilimnium texense J.M. Coult. & Rose is currently treated as either a synonym of *P. costatum* (Elliott) Raf. or a hybrid of *P. capillaceum* (Michx.) Raf. and *P. nuttallii* (DC.) Britton. A study utilizing molecular, morphological, and ecological data was undertaken to determine its taxonomic status. Evidence is presented for the recognition of *P. texense* as a distinct species. *Ptilimnium texense* is endemic to the West Gulf Coastal Plain where it occurs in bogs, acid seeps, and wet pine savannas in east central Texas, west central Louisiana, and southern Arkansas. A key to the genus *Ptilimnium* Raf. is provided.

Key Words: endemic, *Ptilimnium costatum*, West Gulf Coastal Plain

RESUMEN

Ptilimnium texense J.M. Coult. & Rose desde que fue descrita por primera vez en 1909, ha sido considerada un hibrido de *P. capillaceum* y *P. nuttallii* o un sinónimo de *P. costatum*. Se realizó un estudio utilizando datos moleculares y morfológicos para determinar su status taxonómico. Se presentan pruebas para el restablecimiento de *P. texense* como especie. *Ptilimnium texense* J.M. Coult. & Rose es endémica de la Llanura Costera del Golfo Oeste donde se encuentra en turberas, manantiales ácidos, y sabanas húmedas de pino en la parte centro-oriental de Texas, centro-oeste de Louisiana, y sureste de Arkansas. Se presenta una nueva clave para el género *Ptilimnium* Raf.

INTRODUCTION

Ptilimnium texense J.M. Coult. & Rose is currently most commonly treated as a synonym of *P. costatum* (Elliott) Raf., but some authors continue to recognize it as the hybrid *P. ×texense*, with the putative parents *P. capillaceum* (Michx.) Raf. and *P. nuttallii* (DC.) Britton. A recent study utilizing nrDNA ITS sequences indicated that *Ptilimnium texense* was more closely related to *P. costatum* than to *P. capillaceum* or *P. nuttallii* (Feist & Downie 2008), but also brought into question the synonymy of *P. texense* and *P. costatum*. This was followed by extensive herbarium and field studies to examine the taxonomic status of *P. texense*. Combined evidence from morphology, ecology, and DNA sequences indicates that *P. texense* should be reinstated. *Ptilimnium texense* occurs in acidic habitats in the West Gulf Coastal Plain Region of east central Texas, west central Louisiana, and southern Arkansas (Fig. 1).

Taxonomic History.—In 1909 J.M. Coulter and J.N. Rose described *Ptilimnium texense* based on a specimen from Hockley, Texas, collected by F.W. Thurow. They noted that it combined "the cleft involucral bracts, characteristic fruit ribs, and shorter styles of *P. capillaceum* with the stouter habit, smaller fruit, and larger calyx teeth of *P. nuttallii*." In 1945, Mathias and Constance speculated that plants described as *P. texense* "seemed to be of hybrid origin," and listed the putative parents as *P. capillaceum* and *P. nuttallii*. Easterly (1957) was unable to find distinctive characters for *P. texense* and so accepted this assessment, stating that "this plant combines the fruit characteristics of *P. nuttallii* with the vegetative characteristics of *P. capillaceum*." None of these authors, however, presented evidence beyond these statements to support the hybrid status of *P. texense* and later Mathias and Constance relegated it to synonymy under *P. costatum* with no explanation (Lundell 1961). Some authors, however, have continued to recognize *P. ×texense* (Correll & Johnston 1970; Correll & Correll 1972; Diggs et al. 1999) and have given its distribution as eastern Texas in acid bogs and marshlands. These same authors have also continued to recognize *P. costatum* as occurring in Texas.

Molecular Studies.—In a study utilizing nrDNA ITS sequence data (Feist & Downie 2008), specimens

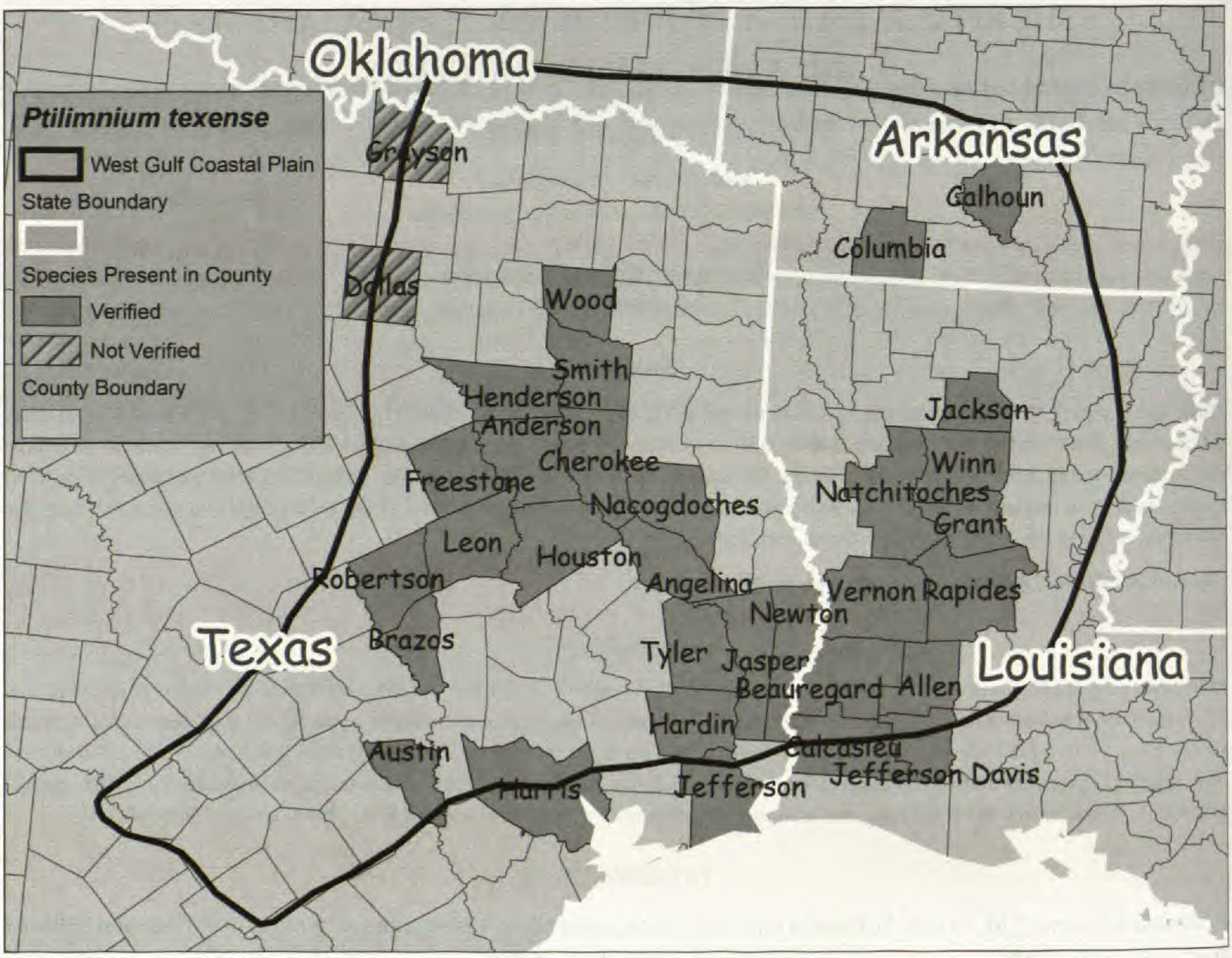

Fig. 1. Distribution of *Ptilimnium texense* in Arkansas, Louisiana, and Texas.

from Texas identified by Easterly as *P. ×texense* did not ally with either of their putative parents (*P. capillaceum* and *P. nuttallii*), but rather showed a close association with *P. costatum*. These specimens formed a strongly supported clade with all specimens identified as *P. costatum* from Texas and Louisiana (hereafter the *P. texense* clade). The *P. texense* clade was sister to another strongly supported clade made up of *P. costatum* from Georgia, Illinois, Missouri, and Tennessee (hereafter the *P. costatum* clade). These results indicated that *P. ×texense* was allied with *P. costatum*, but that populations of each from Louisiana or Texas (the *P. texense* clade) were molecularly distinct (Feist & Downie 2008). Average ITS sequence divergence between the *P. texense* and *P. costatum* clades was 2.6%, which is just slightly less than that between *P. costatum* and *P. capillaceum* (2.9%). Results from a recent analysis of cpDNA sequence data (*trnQ-rps16* 5'exon, *rps16* intron, *rps16* 3'exon-*trnK*) were congruent with the ITS findings (Feist & Downie unpublished data). At first glance, these results seemed to support Mathias and Constance's conclusion (1961) that *P. texense* should be synonymized under *P. costatum*, but morphological differences between specimens making up the *P. texense* clade and the *P. costatum* clade were also observed. Taken together with the geographical and molecular differences, this suggested that members of the *P. texense* clade might represent a taxon distinct from *P. costatum*. Additional herbarium and field studies were undertaken to investigate the taxonomic status of these populations. Morphology, habit, phenology, habitat requirements, and distribution were all considered. The results of these studies are presented below.

METHODS

Field Visits and Morphological Studies.—Six populations of *Ptilimnium*, three in Louisiana and three in Texas, all previously identified as *P. costatum* but determined to be *P. texense* during the course of this study, were visited during Sep 15–21, 2009 (Feist & Molano-Flores specimens listed in Appendix 1). Habitat and associate species were recorded and voucher specimens were collected for additional morphological study. In addition, a total of five plants were collected live and placed in a greenhouse at the Illinois Natural History Survey.

A large number of specimens from the genus *Ptilimnium* were examined during the course of this study. Specimens were either collected by the author or borrowed from the following herbaria: ANHC, AUA, BAYLU, BRIT, DOV, DUKE, EKY, F, FLAS, FSU, GA, ILL, ILLS, JEPS, LAF, LL, LSU, LSUS, MO, NCSC, NCU, NO, NY, OKL, OKLA, OS, OSC, PH, RM, RSA-POM, SMU, TAMU, TENN, TEX, UARK, UC, UNA, UNC, US, USCH, USF, USFS, and WVA. A total of 144 specimens were determined to be *Ptilimnium texense*. These included 4 from Arkansas, 54 from Louisiana, and 86 from Texas (Appendix 1). The majority of these specimens were not identified as *P. texense* prior to this study, but were annotated to *P. texense* by the author.

Morphological data were collected from herbarium specimens. These are summarized in the taxonomic description below, and the characters critical for species identification are highlighted in the key to *Ptilimnium*. Phenology, habitat, and distribution were determined from the herbarium specimens and the accompanying label data and through field visits. Observations of root-budding (cormlet development) were made in the field and in the greenhouse.

HABITAT AND DISTRIBUTION

According to the USDA Plants Database, which treats *Ptilimnium texense* as a synonym of *P. costatum*, *P. costatum* occurs in 25 parishes in Louisiana and 13 counties in Texas (USDA, NRCS 2010). All specimens labeled as *P. costatum* examined by the author from these states are *P. texense* (10 parishes in Louisiana and 19 counties in Texas) or were misidentified collections of *P. capillaceum* or *P. nuttallii*. No specimens of *P. costatum* from Texas or Louisiana were found. Accessions of *P. costatum* cited from Dallas and Grayson counties (Mathias & Constance 1961; Diggs et al. 2006) could not be located. Both species grow in Arkansas but are allopatric, with *P. texense* occurring in two southern counties and *P. costatum* in three counties farther north (Fig.1).

Ptilimnium texense is endemic to the West Gulf Coastal Plain (WGCP). This physiographic region encompasses much of eastern Texas, western Louisiana, southeastern Oklahoma, and southern Arkansas (Fig. 1). Approximately 3900 species occur in the WGCP, which has been divided into four ecoregions: Oak-Pine-Hickory Forest, Longleaf-Pine Forest, Post Oak Savanna, and Prairie (MacRoberts & MacRoberts 2003). *Ptilimnium texense* occurs primarily in the Oak-Pine-Hickory Forest and Longleaf-Pine Forest ecoregions. The primary habitats of *P. texense* are bogs, acid seeps, and wet pine savannas. Common associates include *Pinus palustris*, *Liquidambar styraciflua*, *Acer rubrum*, *Nyssa sylvatica*, *Magnolia virginiana*, *Sphagnum* spp., *Sarracenia alata*, *Oxypolis rigidior*, *Eryngium integrifolium*, *Eriocaulon* spp., *Osmunda regalis* and *O. cinnamomea*. *Ptilimnium texense* can be added to the list of 96 species endemic to the WGCP (MacRoberts et al. 2002). About 9% of WGCP endemics are found in bogs/wet pine savannas, which occupy 10% of the total area of the WGCP (MacRoberts et al. 2002).

DISCUSSION

Ptilimnium texense was proposed as a hybrid of *P. capillaceum* and *P. nuttallii* because earlier authors felt that *P. texense* combined characteristics of these species and possessed no stable characters of its own (Mathias & Constance 1945; Easterly 1957). Upon closer inspection of additional specimens, unique characters that distinguish *P. texense* were found. Contrary to Easterly's assessment, the fruits of *P. texense* and *P. nuttallii* are easily differentiated. The fruits of *P. texense* are longer than those of *P. nuttallii* (2.2–3.5 mm versus 1–1.9 mm) and the dorsal ribs are narrow and blunt versus thick and rounded. Vegetatively, *P. texense* differs from *P. capillaceum* in that its leaf segments are always 3-4-angled to subterete and the midveins are not visible,

whereas the leaf segments of *P. capillaceum* are often flattened and the midveins are apparent. Unique characters of *P. texense* not found in *P. capillaceum* or *P. nuttallii* include root system and habit. Both *P. capillaceum* and *P. nuttallii* have fibrous roots and are annuals, whereas *P. texense* has a distinctive rounded corm at the base of the stem and is a perennial. *Ptilimnium texense* has a more limited geographic range than either *P. capillaceum* or *P. nuttallii*, and more restrictive habitat requirements, as it requires acidic environments such as bogs, acid seeps, and wet pine savannas. Where the ranges of the three species overlap, *P. capillaceum* and *P. nuttallii* flower and fruit much earlier than *P. texense*. By the time *P. texense* begins to flower in August, the fruit of *P. capillaceum* and *P. nuttallii* have already matured and fallen from the plant. The fruit of *P. texense* matures between mid-October and late November.

Molecular data provided no evidence that *P. texense* might be a hybrid. The results of studies utilizing nuclear and chloroplast DNA sequences were congruent (Feist & Downie 2008; Feist & Downie unpublished data) and there were no site polymorphisms visible on the chromatograms of accessions identified as *P. texense*. Incongruence and site polymorphisms may both be signs of hybridization (Baldwin et al. 1995; Alvarez & Wendel 2003). Taken together with the lack of morphological evidence provided by earlier authors and the distinctive characters of *P. texense* presented in this study, the hybrid status of *P. texense* is not supported.

Ptilimnium texense was synonymized under *P. costatum* (Mathias & Constance 1961) and it is most closely related to this species (Feist & Downie 2008). These species share some morphological traits, such as root morphology and perennial habit, but are also distinct in a number of ways (Figs. 2, 3). These differences are highlighted in the last two couplets of the key. A major difference distinguishing the species is their leaf morphology. As with *P. capillaceum*, leaf segments of *P. costatum* differ from those of *P. texense* by being flat with the midvein apparent. Other differences in leaf morphology include geometry and overall shape. The leaves of *P. costatum* are distinctive in that the primary leaf segments become progressively shorter from the leaf base to the apex and the blade apex is acute. In *P. texense*, the primary segments remain about the same length along the rachis and the blade apex is blunt or rounded. The leaves of *P. texense* are also stiffer and more three-dimensional than the leaves of *P. costatum* and the other *Ptilimnium* species. Style length also distinguishes *P. texense* and *P. costatum*. Although there can be some overlap, the styles of *P. costatum* are typically longer [(0.8–)1–2 mm] than those of *P. texense* [(0.3–)0.5–0.8(–1) mm]. There is no overlap, however, in the geographic range of these species and their habitats are different as well, with *P. texense* again requiring a more acidic environment. As mentioned above, both *P. costatum* and *P. texense* are perennials with corms. This structure is usually more elongate in *P. costatum* than in *P. texense* and may be slightly L-shaped. These characters have not been noted in previous studies of *Ptilimnium*. All species of *Ptilimnium* had been thought to be annuals with fibrous roots. *P. costatum* and *P. texense* do develop numerous adventitious roots which may obscure the corm, but both species develop buds from the corm (cormlets) that grow into new stems (Fig. 4).

As *P. texense* has been purported to be a hybrid or not differentiated from *P. costatum*, it has not been included in keys to the genus. It clearly does not fit the description of any of the other species and this has lead to confusion when attempting to identify it. Of the 138 specimens identified as *P. texense* in the course of this study (not including the author's own collections), 22 were not initially identified to species or not identified as *Ptilimnium*, 34 were identified as *P. capillaceum*, 44 as *P. costatum*, 36 as *P. nuttallii*, and just two as *P. texense*. About one-third of these were annotated to *P. ×texense*, *P. capillaceum ×P. nuttallii*, or *P. costatum* by subsequent workers. This poor record of identification clearly demonstrates the need for a more inclusive and refined key. Previous keys to the genus have emphasized style length, number of segments of the involucral bracts, and whether the primary leaf segments are alternate or opposite on the rachis. Although these characters can be useful, there is variability and overlap among them and relying exclusively on these characters can lead to confusion. For this reason, additional characters have been utilized in the key below.

Fig. 2. Scanned image of *Ptilimnium texense* (LAF-46206) collected by D.S. Correll in 1969.

Fig. 3. Scanned image of *Ptilimnium costatum* (ILLS-183385) collected by L.R. Phillippe in 1993.

Fig. 4. Corms with root-budding of *Ptilimnium costatum* (top) and *Ptilimnium texense* (bottom).

KEY TO *PTILIMNIUM*

1. Middle and upper petiole bases papillate on the abaxial surface; styles 0.1–0.2 mm long (on fruit), erect-ascending to spreading; calyx teeth < 0.2 mm, deltoid ____ **P. capillaceum** (including *P. ahlesii*[1])
1. Middle and upper petiole bases not papillate on the abaxial surface; styles (0.3–)0.4–2 mm long (on fruit), spreading to strongly recurved; calyx teeth > 0.2 mm, narrowly triangular.
   2. Mid-stem leaves with 2–4(–5) nodes along the rachis, primary leaf segments usually alternate or opposite at the nodes (not including at the apex of the petiole); individual leaf segments often much longer than the rachis; involucral bract segments 1(–3); roots fibrous, stem sometimes slightly thickened at the base but never forming a corm; styles (0.3–)0.4–0.6 mm long; fruit 1–1.9 mm long, dorsal ribs thick, rounded; flowering Apr–Jul, fruiting late May–early-Aug ____ **P. nuttallii**
   2. Mid-stem leaves with (6–)7–16 nodes along the rachis, primary leaf segments whorled or verticillate at the major nodes; individual leaf segments shorter than the rachis (rarely as long as in *P. texense*); involucral bract segments (1–)3(–7); stem thickened and rounded at the base forming a globose or slightly elongate corm; styles (0.3–)0.5–2 mm long; fruit 2.2–4 mm long, dorsal ribs narrow, sharp-edged to blunt; flowering Jul–Oct, fruiting mid-Jul–Nov.
      3. Leaf segments flat (at least near the nodes but usually throughout), midvein visible; mid-stem leaves with (8–)10–16 nodes per rachis, longest primary segments with 9–22 secondary segments; leaf shape in outline deltoid or trullate (trowel-shaped), leaf segments getting progressively and noticeably shorter towards apex, apex acute; styles (0.8–)1–2 mm long, slightly spreading to spreading; flowering Jul–Oct, fruiting mid-Jul–Oct; bottomland forest, swamps, streambanks, and pond margins ____ **P. costatum**
      3. Leaf segments 3–4-angled to subterete, midvein not visible; mid-stem leaves with (6–)7–10 nodes per rachis, longest primary segments with 3–7(–8) secondary segments; leaf shape in outline oblong or oval, leaf segments not getting progressively and noticeably shorter towards apex, apex blunt; styles (0.3–)0.5–0.8(–1) mm long, spreading to strongly recurved; flowering Aug–Oct, fruiting Sep–Nov; seeps, bogs, and wet pine savannas ____ **P. texense**

TAXONOMIC DESCRIPTION

Ptilimnium texense J.M. Coult. & Rose, Contr. U.S. Natl. Herb. 12:445. 1909. TYPE: U.S.A. TEXAS. Harris Co.: near Hockley, Sep 1890, *F.W. Thurow s.n.* (HOLOTYPE: US).

Plants perennial, 5–12 dm, roots from a small rounded corm at base of stem. **Leaves**: blades 3–12 cm, stiff, 3-dimensional, oblong to oval in outline, apex blunt, mid-stem leaves with (6–)7–10 nodes along the rachis, 3–5 primary leaf segments at the major nodes; leaf segments dissected, filiform to linear, 3–4-angled to subterete, midvein not visible, individual leaf segments shorter than (–as long as) the rachis, primary leaf segments not getting progressively and noticeably shorter towards apex, longest primary segments with 3–7(–8) secondary segments; petioles 0.5–3 cm, hyaline borders narrow, often inconspicuous and only visible at the distal and proximal ends, abaxial surface not papillate at the base. **Peduncle** 2–12 cm. **Umbels** 3–8(–10), rays 8–20(–25), 1–3.5(–4.5) cm, subequal to of varying lengths; involucral bracts linear, entire or 3-parted, rarely further divided. **Pedicels** 2–12 mm. **Flowers** 12–24 per umbellet; calyx teeth conspicuous, 0.2–0.4 mm, narrowly triangular; petals (0.6–)0.7–1.3 mm; styles (0.3–)0.5–0.8 (–1) mm, spreading to strongly recurved. **Schizocarps** 2.2–3.5 × 1.5–2.2 mm, ovate to orbicular, slightly compressed laterally, often maroon- or purple-tinged, dorsal ribs narrow, blunt, corky-thickened extension of the lateral ribs conspicuous; oil tubes dark brown. Flowering/fruiting Aug–Oct/Sep–Nov.

APPENDIX 1

ARKANSAS. Calhoun Co.: 2 mi S of Harrel, clearcut sweetbay Magnolia woods, 17 Sep 1987, *Sundell & Etheridge 7922* (BRIT, NO). **Columbia Co.:** Emerson, 8 Sep 1948, *D.M. Moore 480649* (SMU, UARK).

LOUISIANA. Allen Pa.: off LA 112 ca. 4 mi W of Elizabeth, infrequent in pine forest, 5 Sep 1981, *C.M. Allen 11315* (LSU). **Beauregard Pa.:** beside LA 110 6.5 mi SE of Merryville near Bearhead Creek, wet area, 3 Aug 1974, *R.D. Thomas 40979* (TENN). **Calcasieu Pa.:** Lake Charles, prairies, 14 Sep 1906, *R.S. Cocks s.n.* (NO); 4 mi S of Holmwood, grassy roadside, 23 Sep 1967, *J.W.*

[1] *Ptilimnium ahlesii* Weakley & Nesom (2004) is included under *P. capillaceum* in this key. Studies utilizing nrITS and cpDNA sequences found no molecular difference between these two taxa (Feist & Downie 2008; Feist & Downie unpublished data). The morphological distinctiveness of *P. ahlesii* is also questioned by the author and is currently under review.

Thieret 27955 (LAF); S of Lake Charles, on Hwy. 27, prairie, 19 Sep 1969, *C.A. Brown 20872* (LSU). **Grant Pa.:** Breezy Hill vicinity, ca. 1 mi N, Kisatchie N.F., longleaf pine woods on silty soil in a hillside seepage bog, 18 Aug 1997, *P.E. Hyatt & A. Martin 7691* (USCH). **Jackson Pa.:** beside LA 147 2 mi NW of LA 34 at Winn Parish Line S of Chatham, swampy area, 7 Sep 1987, *R.D. Thomas 101940* (TENN). **Jefferson Davis Pa.:** roadside ditch and RR ROW beside US 165 N of Fenton, 18 Oct 1975, *R.D. Thomas 47944* (FLAS, USCH). **Natchitoches Pa.:** ca. 7.5 mi NE of Kisatchie, in seepage area with pitcher plants, 28 Sep 1974, *C.M. Allen 5961* (LAF); near bridge on Longleaf Vista (FSR 337), ca. 9 mi NW of Gorum, abundant in bog, 28 Aug 1976, K. *Vincent 561* (DUKE, GA, LAF); Red Dirt Game Management Area, Kisatchie N.F., near Montrose Rd., stream near bog, 16 Sep 1976, *W.C. Holmes 2820* (UNA); on Strange Rd. in Kisatchie N.F., N of LA 479 and W of Goldonna near Ragan, bog, 17 Oct 1986, *R.D. Thomas & N. Gilmore 98858* (MO); Strange Road Bog, 0.8–0.9 mi N on FR 570, off Hwy. 479 near Goldonna, Kisatchie N.F., pitcher plant bog, 22 Aug 1987, *B.R. & M.H. MacRoberts 545* (LSUS); Strange Road Bog, 0.8–0.9 mi N on FR 570, off Hwy. 479 near Goldonna, Kisatchie N.F., pitcher plant bog, 20 June 1987, *B.R. & M.H. MacRoberts 432* (LSU); beside USFS 380 (Middle Branch Rd.) S of Longleaf Vista Rd. in Kisatchie N.F., E of LA 117, 17 Sep 1988, *R.D. Thomas 107272* (TENN); beside LA 479 at Strange Rd. W of Goldonna in Kisatchie N.F., moist seepage area, 14 Aug 1989, *R.D. Thomas & D. Bell 112081* (ILL); Kisatchie N.F., Winn Dist., Compt. 18, along Strange Rd. (USFS 570) N of Pitcher Plant Bog and S of Luster Creek, N of LA 479 W of Goldonna, pitcher plant bog, 29 Aug 1997, *R.D. Thomas 155187* (GA); Strange Road Bog, N of LA 479 and FSR 570 NW of Goldonna, pitcher plant bog area in pine forest, 26 Sep 2001, *D.M. Ferguson 366* (LSU); ca. 0.1 mi N of SR 126 and 0.7 mi E of SR 1233 (Pine Ridge) and 0.1 mi N of SR 126, Kisatchie N.F., in bog opening with longleaf pine and pitcher plant, 24 Sep 2009, *M.A. Feist & B. Molano-Flores 4426* (ILLS). **Rapides Pa.:** IPCO slash plantation (thinning study) near Hineston, longleaf pine, 20 Aug 1963, *H.E. Grelan 340* (USFS); next to Pecan Rd., just N of Arrowhead Rd., weedy clearcut longleaf pine forest, 20 Aug 1993, *C. Slaughter & J. Thompson 4115* (LSU); Hwy. 488 to FS 240, left at FS 2402, along dirt track, Kisatchie N.F., Evangeline District, bog with *Rhexia petiolata*, 15 Sep 1993, *J. Bruser 229* (LSU); W of Brushy Creek Rd., 4.85 km SW of S end of West Twin Lake, ca. 7.1 km W of Flagon Bayou, wooded seep, 16 Oct 2003, *P. Douglas, M. Arnett, & N. Hastings 1125* (LSU). **Vernon Pa.:** near Pickering, boggy branch long leaf pine hills with *Magnolia glauca*, black gum, poison sumac, pitcher plant, 3 Oct 1936, *C.A. Brown 6878* (LSU); 2 mi S of Evans along highway to Merryville, roadside near creek, 14 Aug 1967, *A. Lasseigne 730* (LAF); ca. 1.5 mi E of Pickering, roadside ditch, 4 Sep 1967, *J.W. Thieret 27754* (LAF); 2 mi W of LA 464 and Caney, swampy area in pine barrens, 3 Oct 1967, *R.D. Thomas 5515* (FLAS); Hwy. 312 near Toledo Bend Dam on Sabine River, long leaf pine woods, 4 Oct 1969, *C.A. Brown 21067* (LSU); ca. 3.5 mi E of Rosepine, abundant in bog near pond, 25 Sep 1976, *K. Vincent & C.M. Allen 655* (LAF, USF); along Pearl Creek ca. 3/4 mi NE of Burr Ferry on LA 111, infrequent in pine woods along Pearl Creek, 4 Nov 1979, *K. Vincent & C.M. Allen 3220* (LAF); on LA 28 ca. 1.2 mi W of Rapides-Vernon Parish line, pitcher plant bog, 11 Sep 1981, *F.M. Givens 2217* (LSU); W of Plainview Community Rd., 2.6 mi N of LA 392 and Hornsbeck, pitcher plant bog on gentle slope in pine woods, 13 Oct 1985, *R.D. Thomas 94549* (MO, TENN); E of Drake's Creek, ca. 2 mi E of Johnsonville Church and LA 10, ca. 7 mi E of Pickering, Kisatchie N.F., 7 Sep 1987, *R.D. Thomas 101487* (USCH); ca. 0.5 mi N of Big Branch Creek along Plainview Community Rd. 1.5 mi N from LA 392, 0.4 mi E of jct. LA 392 and US 171 in Hornbeck, sandy pasture and roadside with hillside seeps, 23 Aug 1989, *L.E. Urbatsch 5977* (LSU); S of 421 near Yoke Creek, Kisatchie N.F., bog in clay-soiled seepage savanna, 14 Sep 1990, *M.S. Olson 355* (LSU); Fort Polk Army Post, S of Range 8 and 8A, disturbed area in rolling upland, fine sandy loam, 27 Jul 1991, *C.M. Allen & A. Allen PLK0541* (OKL); Cooter's Bog, Kisatchie N.F., longleaf pine savannah with pitcher plant bog, 25 Sep 2009, *M.A. Feist & B. Molano-Flores 4447* (ILLS). **Winn Pa.:** 4 mi W of Winnfield, vicinity of limestone quarry, boggy open soil at edge of pocosin, 3 Aug 1938, *D.S Correll & H.B. Correll 10042* (DUKE); ca. 2.5 mi N of Verda, locally abundant in bog in pine forest, 11 Aug 1976, *K. Vincent & C.M. Allen 7152* (LAF, OS); ca. 1.1. mi E of SR 1233 (at Pine Ridge), just S of SR 126, Kisatchie N.F., roadside with *Cephalanthus occidentalis, Oxypolis rigidior, Eryngium integrifolium*, etc., 24 Sep 2009, *M.A. Feist & B. Molano-Flores 4442* (ILLS).

TEXAS. Anderson Co.: Gus Engeling W.M.A., NW of Palestine, boggy area around Lake 2, 28 Sep 1980, *C. Crozier s.n.* (BAYLU); Gus Engeling W.M.A., NW of Palestine, Lake 2 bog area, pasture 2, boggy area, with *Eupatorium, Helianthus, Eryngium*, 16 Oct 1993, *M. Dubrule Reed 1353* (TAMU); Gus Engeling W.M.A., NW of Palestine, Lake 2 bog area, pasture 2, sandy soil, with *Eupatorium, Helianthus, Eryngium*, 16 Oct 1993, *M. Dubrule Reed 1354* (TAMU); Chester's Pitcher Plant Bog, N end of Gus Engeling W.M.A., on Gibson Branch, S of FM 2961 just downstream from lake, pitcher plant bog, 9 Aug 1997, *B.R. & M.H. MacRoberts 3412* (BRIT, TEX). **Angelina Co.:** Angelina near Boykin Springs, Angelina N.F., seepage slope along stream in longleaf pine area, 30 Nov 1962, *D.S. Correll 26860* (LL); 2 mi NW of Bouton Lake along road on way to Rte. 69, Angelina N.F., on open-wooded seepage slope, 30 Nov 1962, *D.S. Correll 26883* (LL); about lake at Boykin Springs, Angelina N.F., wet soil, 7 Sep 1967, *D.S. Correll 34925* (LL); SW of FSR 313 and FSR 313A, N of Boykin Spring Recreation Area, Angelina N.F., acid seep in old-growth, burned, dry upland longleaf pine savannah, 14 Aug 1989, *S.L. Orzell & E.L. Bridges 11438* (TEX). **Austin Co.:** Austin Co., 15 Oct 1939, *B.C. Tharp s.n.* (MO, TEX). **Brazos Co.:** at College Station, road ditch, 25 Aug1948, *N.L. Byrd 230* (OSC). **Cherokee Co.:** Jacksonville, 8 Oct. 1884, *J.F. Joor s.n.* (MO). **Freestone Co.:** ca. 14.5 mi S of Fairfield, in bog, sandy valley bottom, 2 Oct 1949, *L.H. Shinners 11830* (SMU); ca. 15 mi S of Fairfield on US 75, 20 Sep 1958, *H. Gentry 2897* (BRIT, UNC); Womach Ranch, 7 mi NE of Buffalo, deep muck quaking bogs, upland basin (bowl), 17 Sep 2003, *J. Singhurst & E. Bridges 12343* (BAYLU). **Hardin Co.:** Nona, damp flat pinebarrens, 15 Nov 1893, *C. Mohr s.n.* (US); cut over longleaf pine, 5 Sep 1924, *B.C. Tharp 3158* (TEX); near Kountze, in sour flat in longleaf pine, 25 Aug 1945, *S.R. Warner 47-12* (TEX); 4 mi W of Silsbee, savannah, 10 Oct 1965, *D.S. Correll 31994* (LL, MO); along roadside of Hwy. 327 between Silsbee and Kountz, along pipeline crossing, 30 Sep 1971, *P.A. Amerson 834* (SMU); Roy

E. Larson Sandylands Preserve, Tract 4, ca. 3.3 mi E of jct. of Hwy. 69 and Hwy. 418 on 418, S side of 418 and W side of Village Creek, 12 Aug 1994, *J. Singhurst 2270* (BAYLU); Roy E. Larson Sandylands Preserve, Tract 4, ca. 3.3 mi E of jct. of Hwy. 69 and Hwy. 418 on 418, S side of 418 and W side of Village Creek, 15 Oct 1994, *J. Singhurst 2019* (BAYLU); Roy E. Larson Sandylands Preserve, Tract 4, ca. 3.3 mi E of jct. of Hwy. 69 and Hwy. 418 on 418, S side of 418 and W side of Village Creek, 15 Oct 1994, *J. Singhurst 2050* (BAYLU); roadside ditch just outside of Roy E. Larson Sandylands Preserve, within the Hyatt Lake Estates, roadside ditch near longleaf pine savannah, 25 Sep 2009, *M.A. Feist & B. Molano-Flores 4464* (ILLS). **Harris Co.:** near Hockley, Sep 1890, *F.W. Thurow s.n.* (US). **Henderson Co.:** 8 mi from Athens, seepage slope along stream, 28 Aug 1946, *V.L. Cory 14188* (LL). **Houston Co.:** Grapeland, open sandy bogs, 16 Sep 1918, *E.J. Palmer 14423* (MO). **Jasper Co.:** off TX 63 NW of Beans Place, in pineland, 10 Sep 1942, *C.L. & A.A. Lundell 11903* (LL); in longleaf pine region in rolling country, 6 mi N of Kirbyville, evergreen shrub bog, 10 Nov 1962, *D.S. Correll 26755* (LL); 2 mi W of McGee Bend Dam, seepage slope among *Magnolia virginiana* and *Sarracenia*, 13 Nov 1963, *D.S. Correll 28638* (LL); Boykin Bog, bog, 23 Aug 1964, *R.P. Turner 144* (TEX); N side of Little Rocky Creek NE of Grubbs House, Little Rocky Preserve, ca. 3.4 mi E of jct. US 96 and FM 1007 near Browndell, locally frequent in wet sandy soil in forested seep in loblolly pine-hardwoods forest below open hillside seepage bog, 24 Sep 1997, *W.R. Carr 17060* (TEX); E of CR 348A, along small roadside stream in cutover longleaf pine savannah, 25 Sep 2009, *M.A. Feist & B. Molano-Flores 4458* (ILLS); E of CR 348A, along small stream in cutover longleaf pine savannah, 25 Sep 2009, *M.A. Feist & B. Molano-Flores 4463* (ILLS). **Jefferson Co.:** Beaumont, 15 Sep 1936, *J.L. Hooks s.n.* (TEX). **Leon Co.:** ca. 8.5 mi NE of Buffalo on US 79, seepage *Sarracenia* bog, 16 Sep 1994, *W.C. Holmes 7466* (BAYLU); Cripple Fawn Ranch, NE of Flynn, *Sarracenia* bog with *Pluchea, Myrica, Lobelia*, and *Solidago*, 10 Nov 1995, *M. Dubrule Reed 1738* (TAMU). **Nacogdoches Co.:** near Nacogdoches, 24 Sep 1938, *E. Whitehouse 11376* (SMU). **Newton Co.:** SF 1, 5 mi E of Kirbyville, moist sandy woods, 30 Sep 1945, *V.L. Cory 49817* (SMU, US); 1.5 mi E of county line along Farm Rd. 363 to Bon Wier, savannah between road and railroad, 30 Oct 1968, *D.S Correll & H.B. Correll 36692* (LL); 5 mi due W of Deweyville, edge of moist woods, 14 Sep 1968, *D.S. Correll 36530* (LL); Scrappin Valley Distinctive Site, Temple Inland Corp Land, 5.1 mi N of jct. of R 255 and Hwy. 87 at Mayflower Community on Hwy. 87, E side of Hwy. 87, *Sphagnum*-beakrush community, hill-side seepage slope bogs, acid seep spring bogs, 15 Oct 2002, *J. Singhurst 11262* (BAYLU). **Robertson Co.:** near Newbaden, widespread on bog, 30 Oct 1943, *J.J. Brady, B.C. Tharp, & F.A. Barkley 13750* (DUKE, MO NO, OKL, OKLA, RM, TEX, UARK, UNC, US); 15 mi SE of New Baden, moist area of bog, 11 Oct 1948, *E.M. Trew, Jr. 96* (TEX); 4 mi E of New Baden, bog, 21 Aug 1948, *G.L. Webster & C.M. Rowell 1904* (TEX); 5 mi E of New Baden, peat bog, 24 Oct 1948, *G.L. Webster & C.M. Rowell 1953* (TEX, UARK); Southworth bog, ca. 15 mi SE of New Baden, moist portion of bog, 11 Oct 1948, *J.J. Sperry 2157* (TAMU); Southworth Peat Bog, 12 mi E of New Baden, bog in Carrizo sands with cattails, pitcher plants, and panic grass, 20 Aug 1954, *E.L. Rabb 108* (TAMU); S.W. 1/4 Camp Creek Lake Quad., Mill Creek Bog, bog, 4 Oct 1981, *T. Starbuck 1097* (BRIT, TAMU). **Smith Co.:** Swan, swamps, 17 Sep 1902, *J. Reverehon 3193* (MO, US); Swan, swamps, 17 Sep 1902, *J. Reverchon s.n.* (MO, US); western Tyler, on ROW of Cotton Belt Railway, frequent in muddy ground along a small drainageway, 5 Sep 1949, *V.L. Cory 56892* (US). **Tyler Co.:** Kirby Forest, near Warren and Kountze, 25 Aug 1945, *S.R. Warner 475* (TEX); ca. 2 mi NE of Warren, in a draw near a creek, 1 Oct 1945, *V.L. Cory 49869* (OKLA, SMU, US); 2.5 mi S of Warren, frequent in pitcher plant bog, 28 Sep 1948, *V.L. Cory 54898* (LL, SMU); ca. 10 mi E of Hillister on road to Spurger, evergreen shrub bog, pinelands, 15 Nov 1963, *D.S. Correll 28680* (LL); ca. 2 mi S of Warren on Rte. 69, boggy area, 15 Oct 1969, *D.S. Correll 38163* (LAF, LL, MO, UNC); Turkey Creek Unit, Big Thicket National Preserve, longleaf pine-black gum savannah, 10 Sep 1981, *A. Pecotte 32* (TAMU); NW corner of Big Thicket Bogs & Pineylands Preserve (TNC), 100 ft S of CR 4770, ca. 0.4–0.5 mi E of its jct. with US 69/287 near Lake Hyatt, frequent in moist to wet sandy loam in portion of boggy wetland with *Sphagnum* and *Sarracenia*, 25 Sep 1997, *W.R. Carr 17084* (TEX). **Wood Co.:** in a bog below dam of a small lake, ca. 2 mi N of Mineola, Rte. 37, bog, 29 Sep 1967, *D.S. Correll 35023* (LL). **County unknown:** damp flat pinebarrens, 15 Nov 1893, *C.N. Sabain s.n.* (US).

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REFERENCES

Alvarez, I. and J.F. Wendel. 2003. Ribosomal ITS sequences and plant phylogenetic inference. Molec. Phylogenet. Evol. 29:417–434.

Baldwin, B.G., M.J. Sanderson, J.M. Porter, M.F. Wojciechowski, C.S. Campbell, and M.J. Donoghue. 1995. The ITS region of

nuclear ribosomal DNA: a valuable source of evidence on angiosperm phylogeny. Ann. Missouri Bot. Gard. 82:247–277.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular flora of Texas. Texas Research Foundation, Renner.

Correll, D.S. and H.B. Correll. 1972. Aquatic and wetland plants of the southwestern United States. Environmental Protection Agency, Washington D.C.

Diggs, G.M., B.L. Lipscomb, and R.J. O'Kennon. 1999. Illustrated flora of north central Texas. Sida, Bot. Misc. 16:1–1626.

Diggs, G.M., B.L. Lipscomb, M.D. Reed, and R.J. O'Kennon. 2006. Illustrated flora of east Texas. Sida, Bot. Misc. 26:1–1594.

Coulter, J.M. and J.N. Rose. 1909. Supplement to the monograph of the North American Umbelliferae. Contr. U.S. Natl. Herb. 12:441–451.

Easterly, N.W. 1957. A morphological study of *Ptilimnium*. Brittonia 9:136–145.

Feist, M.A. and S.R. Downie. 2008. A phylogenetic study of *Oxypolis* and *Ptilimnium* (Apiaceae) based on nuclear rDNA ITS sequences. Syst. Bot. 33:447–458.

Lundell, C.L. 1961. Flora of Texas. Texas Research Foundation, Renner.

MacRoberts, M.H. and B.R. MacRoberts. 2003. West Gulf Coastal Plain ecoregions. Sida 20:1247–1276.

MacRoberts, M.H., B.R. MacRoberts, B.A. Sorrie, and R.E. Evans. 2002. Endemism in the West Gulf Coastal Plain: importance of xeric habitats. Sida 20:767–280.

Mathias, M.E. and L. Constance. 1945. Umbelliferae, N. Amer. Fl. 28B:43–295.

Mathias, M.E. and L. Constance. 1961. Umbelliferae. In: C.L. Lundell, ed. Flora of Texas, vol. 3. Texas Research Foundation, Renner. Pp. 263–329.

USDA, NRCS. 2010. The PLANTS Database (http://plants.usda.gov, 1 April 2010). National Plant Data Center, Baton Rouge, LA 70874-4490, USA.

Weakley, A.S. and G.L. Nesom. 2004. A new species of *Ptilimnium* (Apiaceae) from the Atlantic coast. Sida 21: 743–752.

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Contents

Preface
Chapter 1 The Significance of Systematics
Chapter 2 How Plants Get Their Names
Chapter 3 How Plants Are Identified
Chapter 4 Collecting, Handling, and Preserving Specimens
Chapter 5 History and Development of Classification to the Twenty-First Century
Chapter 6 Plant Classification in the Twenty-First Century
Chapter 7 Living Ferns and Other Seedless Vascular Plants (Pteridophytes)
Chapter 8 Families of the Pinophyta (Gymnosperms)
Chapter 9 Terminology of Flowering Plants (Angiosperms)
Chapter 10 Families of Flowering Plants (Angiosperms)—"Basal" Flowering Plants, Magnoliids, Monocots, and Commelinids
Chapter 11 Families of Flowering Plants (Angiosperms)—Eudicots I
Chapter 12 Families of Flowering Plants (Angiosperms)—Eudicots II. Rosids and Eurosids
Chapter 13 Families of Flowering Plants (Angiosperms)—Eudicots Asterids—Euasterids I, II
Chapter 14 The Literature of Systematics
Chapter 15 Contemporary Views on the Origin of Vascular Plants
Chapter 16 Methods for Studying the Systematics of Plants
Chapter 17 Preserving Plant Biodiversity
Chapter 18 The Role of Botanical Gardens in Society
Chapter 19 Epilogue
Appendix I: Selected References
Appendix II: Floras of the World
Appendix III: Classification of the Flowering Plants as Proposed by the Angiosperm Phylogeny Group (APG)
Glossary
Index

This basic text on systematics is a great general introduction for a beginning college student. It gives an overview without too much of the minutiae associated with more advanced texts.

A NEW VARIETY OF *BROMUS FLEXUOSUS* (POACEAE: POOIDEAE: BROMEAE: SECT. BROMOPSIS)

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ABSTRACT

Bromus flexuosus was evaluated morphologically using discriminant characters and phenetic cluster analysis. The results support the recognition **Bromus flexuosus** var. **famatinensis** Planchuelo as a new variety. A morphological description, habitat, geographical distribution, and representative specimens of both varieties of *Bromus flexuosus* are included along with statistical information, a key, synonymies, species descriptions, illustrations, and citations of representative specimens of allied species (*B. lanatus* Kunth and *B. modestus* Renvoize) growing in the Central Andes.

Key Words: *Bromus*, *Bromopsis*, Poaceae, Bromeae, South America

RESUMEN

Bromus flexuosus fue evaluado morfológicamente usando caracteres discriminantes y análisis fenético de agrupamiento. Los resultados soportan el reconocimiento de la nueva variedad **Bromus flexuosus** var. **famatinensis** Planchuelo. Se presenta la descripción, hábitat, distribución geográfica y especimenes representativos de las dos variedades de *Bromus flexuosus*, junto con datos estadísticos, clave dicotómica, sinonimia, descripciones, ilustraciones y especimenes representativos de las especies afines (*B. lanatus* Kunth y *B. modestus* Renvoize) que crecen en los Andes Centrales.

Palabras Claves: *Bromus*, *Bromopsis*, Poaceae, Bromeae, Sudamérica

In 1983, Planchuelo described *Bromus flexuosus* as an endemic species for northwestern Argentina. The species seemed unrelated to any other species of section *Bromopsis* Dumort. cited for the country in the available floras (Burkart 1969; Cámara Hernández 1970, 1978). Along with the original description, Planchuelo (1983) separated the specimens into two altitudinal ecotypes, which were identified as Group I and II, leaving the taxonomic status of each Group for future investigation. In the following treatments of *Bromus* for Argentina (Zuloaga et al. 1994; Gutiérrez & Pensiero 1998) and for the Americas (Planchuelo & Peterson 2000; Pavlick et al. 2003), no infraspecific taxa were considered for *B. flexuosus*. More recently, during a revision of *Bromus* toward a preparation of a monograph for South America and with the aim to provide a better understanding of the species of section *Bromopsis* growing in the northwestern Argentina and the Central Andes, current literature and specimens of different herbaria were reviewed. Additional collections of *B. flexuosus* were reported for Peru (Saarela et al. 2006) and for Bolivia (Planchuelo 2010) which expanded the area of distribution of the species northward in the Andes. The affinities (panicles and pedicels flexuosity) and the differences (sizes and pubescence of glumes and lemmas) between *B. flexuosus* and other species of section *Bromopsis* were defined in a partial review of species for the Central Andes (Planchuelo 2009).

In an effort to determine the differences among *B. flexuosus* and related taxa (*B. lanatus* and *B. modestus*) all having a flexuous panicle, a phenetic cluster analysis based on morphological characters, as well as an evaluation of discriminant characters was performed on herbarium specimens.

Based on the cluster analysis and selected discriminant characters, I present evidence for two varieties. A detailed description, habitat information, geographical distribution, representative specimens, and illustration for *B. flexuosus* var. *famatinensis* are provided. Also, taxonomic keys to identify the varieties of *B. flexuosus* and the related taxa are included.

MATERIALS AND METHODS

The morphological data were obtained from herbarium specimens as cited. Vegetative and floral structures were included in the data matrices in order to establish the relationship between the studied materials and the taxa that they represent. The taxa considered were *B. flexuosus*, *B. lanatus*, and *B. modestus*. References for identification are Hitchcock (1927), Planchuelo (1983), Pinto-Escobar (1981, 1986), Matthei (1986), Tovar (1993), Renvoize (1994, 1998), Gutiérrez and Pensiero (1998), and Planchuelo and Peterson (2000). *Bromus pitensis* considered by Planchuelo (1983) as a related species of *B. flexuosus* was not considered in this study because it does not have the typical flexuous pedicels (Planchuelo 2010) and the nodding panicles make the species more related to *B. segetum* Kunth.

Measurements for each variable were taken with the use of 10–15× magnifying lens, and the more frequent value (mode) of that character for each specimen was recorded. Measurements of first and second glumes were recorded independently; however, pubescence of both glumes were considered as only one datum and lemma characters were taken from second lemma only, according to Planchuelo (1991). Leaf distribution on main culm was coded as: 1 = leaves only at the base of the plant; 2 = leaves at the base of the plant and along the culms. Leaf blade pubescence for each surface was divided into three states from 1 to 3: 1 = glabrous; 2 = scattered pubescent along nerves and margins; 3 = scattered to densely pubescent on all surfaces. Pedicel pubescence was divided into three states: 1 = glabrous; 2 = scabrous to scattered pubescent; 3 = densely pubescent to lanate. Glumes pubescence was divided into three states: 1 = glabrous to glabrate; 2 = evenly scattered pubescent; 3 = pubescent all over and dense at the base and margins. Lemma pubescence was scored for three states: 1 = glabrous to glabrate; 2 = scattered pubescent and villous only at the base; 3 = dense pubescent all over and villous at the base and along margins. Maximum and minimum values, as well as mean (μ) and coefficient of variation (CV), expressed in percentage were calculated for all continuous variables. The mode (M) was calculated for discrete variables such, leaf distribution, number of spikelets, florets, and nerves.

The results presented here are based on the analysis of a matrix containing the following 17 morphometric parameters: plant height; leaves disposition in the plant; blade width and pubescence above and below; panicle length and number of spikelets; pedicel pubescence; spikelets length and number of florets; first glumes length, second glumes length; pubescence of glumes, second lemma length, number of nerves, pubescence and awn length. The cluster analysis (Sneath & Sokal 1973) was base on 39 Operational Taxonomic Units (OTU) using Manhattan distance coefficient and the unweighted pair grouping method of arithmetic average (UPGMA) (Michener & Sokal 1957).

Specimens included in the multivariate analysis are identified with the OUT's identification number between brackets (e.g., [10]). Data on geographical distribution, elevation and habitat are based on herbarium specimen labels and personal field observations.

RESULTS AND DISCUSSION

Most of the characters have low (<20% CV) to moderate (<40% CV) variability; except the character "plant height" which CV was over 40% (Table 1). Small plants and narrow blades of *B. flexuosus* are usually associated with specimens collected at high altitude and they are correlated with species habitat as it was reflected by the relatively low CV (less than 20%) found when the statistical analysis was done with selected samples from similar altitudinal range. Panicle length shows very good correlations with plant heights; however, its CV is less than 30% in all three species. The comparison of panicle length, number of spikelets and plant height shows that *Bromus lanatus* and *B. modestus* have lower number of spikelets and much larger plants than *B. flexuosus* given the same length of panicles. These relationship of characters along with large sizes of glumes, lemmas and awns, and the constant number of seven nerves in lemmas present in *B. flexuosus*, are the main discriminant components that separate the three species in two clusters (Fig. 1). *Bromus modestus* is the only species with leaves present only at the base of the plant; therefore, this feature along with the lack of pubescence in pedicels and glumes, are the main discriminant characters between this species and

Table 1. Comparison of Continuous and Discrete Variables indicating: the Minimum (Min) and Maximum (Max) measurement, total number of specimens (n) used in the discrimination analysis; the Mean (μ) for continuous variables, the Mode (M) for discrete variables and the Coefficient of Variation (CV) expressed in percentage.

Characters		***B.*** **var.** ***flexuosus*** **n = 11**				***B.*** **var.** ***famatinensis*** **n = 8**				***B. lanatus*** **n = 12**				***B. modestus*** **n = 8**			
		Min	**Max**	**μ/M**	**CV**	**Min**	**Max**	**μ/M**	**CV**	**Min**	**Max**	**μ/M**	**CV**	**Min**	**Max**	**μ/M**	**CV**
Plant	Height (cm)	40	70	55.45	17.36	15	50	27.25	43.14	10	30	16.75	44.97	10	35	18.00	45.13
Blade	Width (mm)	3.5	7.0	4.71	23.81	1.5	4.0	2.88	29.03	1.0	3.5	2.29	34.13	1.0	3.0	1.90	33.29
Panicle																	
	Length (cm)	13.0	25.0	17.18	26.13	8.0	18.0	13.00	26.96	4.0	11.0	8.04	28.98	3.0	8.0	5.56	18.6
	# Spikelets	8.0	25.0	16	-	8.0	14.0	10	-	4	10	7	-	3	6	5	-
Spikelets																	
	Length (mm)	18.0	24.0	20.27	9.12	16.0	24.0	19.63	13.60	13.0	16.0	13.71	9.64	10.0	15.0	12.31	13.19
	# florets	6	8	8	-	5	8	6	-	4	6	5	-	3	6	4	-
Glumes																	
	1st length (mm)	7.0	9.0	8.11	10.88	8.0	11.0	9.81	16.18	5.0	7.0	5.78	12.77	5.0	7.0	5.78	11.59
	2nd length (mm)	8.0	11.0	9.27	10.88	10.0	12.0	10.75	10.17	7.5	8.5	7.80	7.11	7.0	8.0	7.33	4.36
	Length (mm)	11.0	13.0	12.12	6.14	11.0	14.0	12.25	8.61	9	11	9.88	7.20	7	9.0	7.93	8.00
	# nerves	-	7	7	-	-	7	7	-	5	5	5	-	5	5	5	-
Awn	length (mm)	5.0	8.0	6.62	14.6	4.5	7.0	5.54	14.12	3.0	3.5	3.20	7.5	2.0	3.50	2.98	18.12

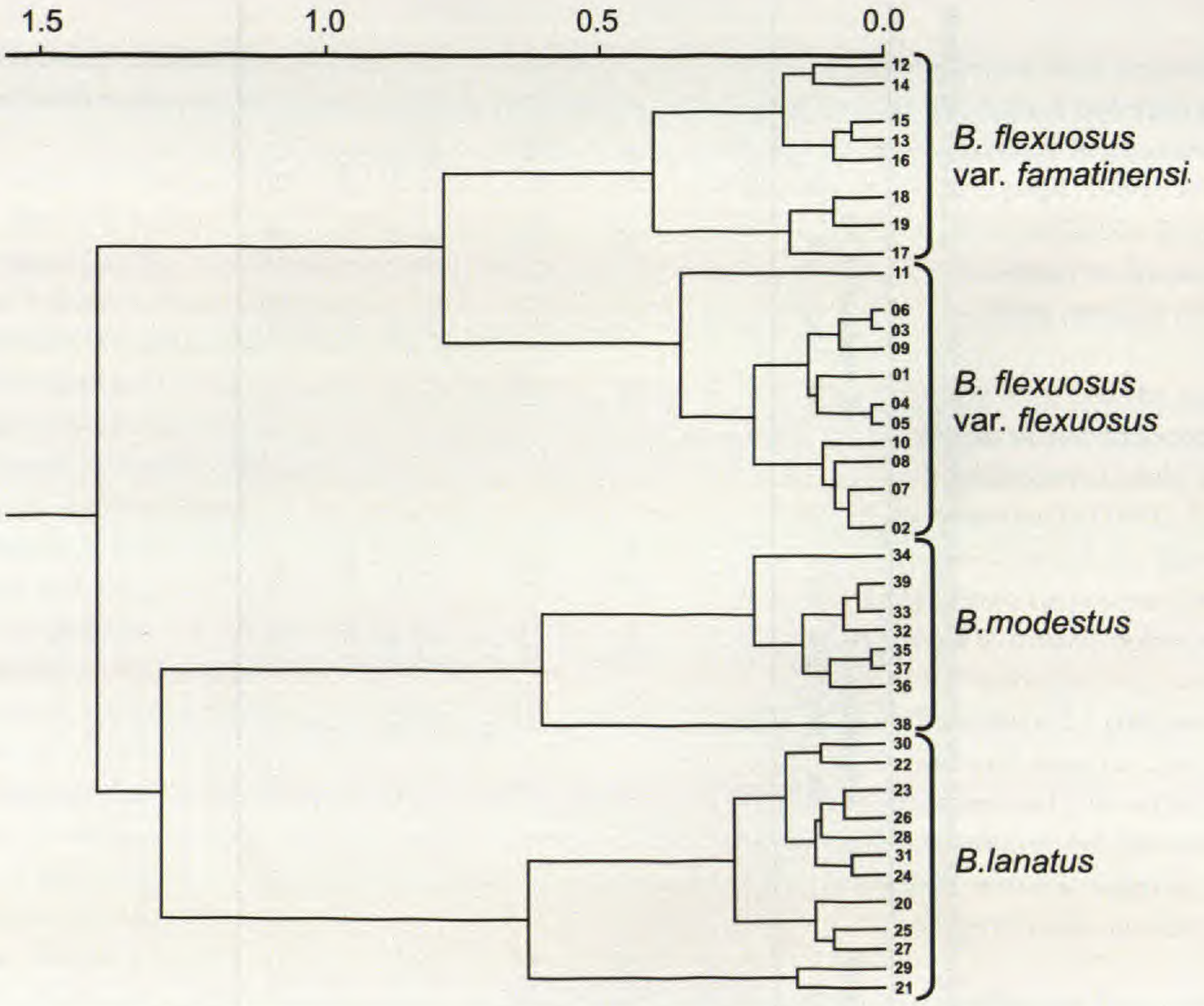

Fig. 1. A UPGMA Phenogram of 39 OTUs based on 17 vegetative and floral characters.

B. lanatus. The differences between varieties of *B. flexuosus* are glumes sizes and pubescence distribution in blades and glumes.

The results shows that, although the taxa have some overlapping in vegetative and floral measurement and in some cases they have similar pubescence characteristics (Table 2), the combination of all the features in the cluster analysis (Fig. 1) clearly separates the 39 analyzed specimens into two main groups. One cluster comprises all representative OTUs of *B. flexuosus* divided into two secondary branches that represent the two varieties; and the other main cluster has two secondary branches that correspond to the specimens identified as *B. lanatus* and *B. modestus*. It is important to point out that in this review the specimen Kurtz 1672a (CORD) cited as *B. flexuosus* in Planchuelo (1983) are now cited as *B. modestus*, species which was not described at the time of the publication of *B. flexuosus*. This new identification approach allowed a better taxa definition, as it is presented in the following taxonomic treatment.

TAXONOMIC TREATMENT

KEY TO THE SPECIES *BROMUS FLEXUOSUS*, *B. LANATUS*, AND *B. MODESTUS*

1. Panicles (8–)10–20(–25) cm with (8–)10–25 spikelets and (5–)6–8 florets; first glumes (7–)8–10 (11) mm long, second glumes (8–)9–11(–12) mm long; lemmas 11–14 mm long, 7-nerved, the awns (4.5–)6–7(–8) mm long **1. B. flexuosus**
1. Panicles (3–)4–8(–11) cm long with (3–)4–8(–10) spikelets and 3–5(–6) florets; first glumes 5–7 mm long, second glumes 7–8.5 mm long; lemmas 7–10(–11) mm long, 5-nerved, the awn 2–3.50 mm long.
   2. Plants with basal and cauline leaves; pedicels lanate **2. B. lanatus**
   2. Plants with basal leaves only; pedicels glabrous to scabrous, less frequent scattered pubescent **3. B. modestus**

TABLE 2. Comparison of Attribute Variables indicating: the number of specimens which have the coded character, from the total number of specimens used in the discriminant analysis.

	Leaves disposition		Blade pubescence			Blade pubescence above			Pedicels pubescence below			Glumes pubescence			Lemma pubescence		
Characters code numbers	1	2	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Bromus flexuosus																	
var. *flexuosus* *n* = 11	–	11	–	5	6	5	6	–	–	7	4	–	–	11	–	3	8
var. *famatinensis* *n* = 8	–	8	6	2	–	–	1	7	–	6	2	–	8	–	–	2	6
Bromus lanatus *n* = 12	–	12	–	4	8	–	4	8	–	–	12	–	–	12	–	–	12
Bromus modestus *n* = 8	8	–	2	4	2	2	4	2	6	2	–	6	2	–	1	7	–

1. Bromus flexuosus Planchuelo, Kurtziana 16:123–131. 1983.

Caespitose perennials. Culms (15–)30–60(–70) cm tall, base covered with loose non fibrous sheaths and leaves. Leaf sheaths retrorse pubescent or scabrous; ligules 1.5–2.5 mm long, lacinate; auricles 1–2 mm long, caducous; blades (10–)20—30(–50) cm long × (1.5–)3.5–6(–7) mm, glabrous, scattered pubescent in nerves to densely pubescent above and below. Panicles (8–)10–20(–25) cm long, open, with (8–)10–25 spikelets, branches and pedicels very flexuous, scabrous, scattered pubescent to lanate. Spikelets (16–)18–20(–24) mm long, with (5–)6–8 florets, slightly imbricate, internodes visible at maturity; glumes narrow-triangular; first glumes (7–)8–10(–11) mm long, 1-nerved; second glumes (8–)9–11(–12) mm long, 3-nerved, mucronate, scattered to pubescent all over and more dense at the base and margins; lemmas 11–14 mm long, ovate, 7-nerved, scattered to densely pubescent all over and villous at the base and margins, awns (4.5–)6–7(–8) mm long. Paleas almost equal to the lemma in length; anthers 0.8–1.2 mm long. Caryopsis 10–11 mm long, widely furrowed not adhering to the palea or lemma.

The two proposed varieties can be easily identified by the following key:

KEY TO THE VARIETIES OF *BROMUS FLEXUOSUS*

1. Blades glabrous or sometimes sparsely pubescent along the nerves and margins above, sparsely to densely pubescent below; panicles 8–13(–18) cm long; glumes evenly scattered pubescent, the first (8–)9–10(–11)mm long, the second 10–11(–12) mm long __________ **B. flexuosus** var. **famatinensis**
1. Blades scattered to densely pubescent above, glabrous or sparsely pubescent along the nerves and margins below; panicles (13–)15–25 cm long; glumes pubescent all over and dense at the base and margins, the first 7–8(–9) mm long, the second 8–10(–11) mm __________ **B. flexuosus** var. **flexuosus**

Bromus flexuosus Planchuelo var. **famatinensis** Planchuelo, var. nov. (**Fig. 2B**). TYPE: ARGENTINA. LA RIOJA. Dpto. Famatina: Sierra de Famatina, La Vega de la Mesada, (28°58'S, 67°47'W) 3650, m 15–16 Mar 1906, *Kurtz 13894* (HOLOTYPE: CORD!; ISOTYPE: US!).

Herba perennis, (15–)20–40(–50) cm alta. Lamina 10–15 cm longa, 1.5–4.0 mm lata, pagina adaxialis grabra vel laxa pubescens in margine et nerves, abaxialis pubescens. Panicula laxa flexuosa 8–13(–18) cm longa. Spicula 16–24 mm longa, 5–8-florae. Glumae pubescens, gluma inferiore angusto-triangulata, (8–)9–10(–11)mm longa, 1.5 mm lata, 1-nervata; gluma superiori angusto-ovata, 10–11(–12) mm longa, 2.5 mm lata, 3-nervata. Lemma ovata, 11–14 mm longa, 2.5–2.8 mm lata, 7-nervata, base et marginibus villosis, arista (4.5–)5–6(–7) mm longa.

Etymology.—The epithet "famatinensis" was chosen to reflect the major region of distribution, and specially the place where this new variety grows.

Distribution and Habitat.—Native in the mountains of northwestern Argentina and in the central Andes of Bolivia and Peru. The new variety grows in the same mountain slopes as the typical variety but at altitudes above 3000 m.

Comments.—The specimens *Burkart & Troncoso 11920* and *Parodi 7976* were erroneously cited by Gutiérrez and Pensiero (1998) as *B. lanatus*. The specimen *Kurtz 1672a* (CORD) cited as *B. flexuosus* in Planchuelo (1983) are now cited as *B. modestus*.

Fig. 2. *Bromus flexuosus* var. *flexuosus*. **A.** Habit, **a.** Spikelet (*A:T Hunziker 20464,* CORD, illustration from Planchuelo 1983 by L. Sánchez); *B. flexuosus* var. *famatinensis*, **B.** Habit, **b.** Spikelet (*Kurtz 13894,* CORD, illustration by Planchuelo). *B. lanatus*. **C.** Habit, **c.** Spikelet (*Peterson et al 14750,* ACOR, illustration by Planchuelo); *B. modestus* **D.** Habit, **d.** Spikelet (*Peterson et al. 16215,* ACOR, illustration by Planchuelo).

Representative specimens examined. **ARGENTINA. Catamarca:** Dpto. Ambato, subiendo desde El Rodeo hacia el Cerro Manchado, cerca de la Casa de Piedra del Primer Campo, 3500 m, 22 Feb 1971, *AT Hunziker 20989* (CORD). **Jujuy:** Caspala, cerros. 1 Mar 1940. Burkart & Troncoso 11920 (BAA). **La Rioja:** Chilecito: Sierra de Famatina, camino a La Mejicana, estación 6–7, 3800 m, 4 Feb 1927, *Parodi 7976* (BAA, US); En las cercanías de la mina El Oro, 23/25 Jan 1879 *Hieronymus 433* (CORD[17]). Famatina: La vega de La Mesada, ca. 3650 m, 15–16 Mar 1906, *Kurtz 13894* (CORD[12], US); Mina San Juan, 3050–3200 m, 21 Feb 1906 *Kurtz 13602* (CORD[15]); Bajada entre la Cumbre de la Cuesta de La Mesada y La Cienaga de los Arenales, 3600–3750 m, 21 Mar 1906, *Kurtz 13989* (CORD); Ciénaga de la Calera, 3600–3650 m, 20 Mar 1906, *Kurtz 13937* (CORD[14]); La Mesada, río Amarillo superior. 3500, 25 Mar 1906, *Kurtz 13836 & 13836 bis* (CORD); Las Trancas, Cerro Coloradito, 12 Mar 1907, *leg. R Tejada s/n, Kurtz 14595* (CORD[16]); Real Viejo, 6 Mar 1907, *Kurtz 14758* (CORD); Cueva de Pérez, 26/28 Jan 1879, *Hieronymus et Niederlein 401* (CORD[18]). Dpto. General Sarmiento, El Volcán, 28 Feb 1907, *Kurtz 14642* (CORD); same place, 28 Feb 1907, *Kurtz 14650* (CORD[13]); Las Cortaderas, entre El Peñón y El Jagüel, 27 Feb 1879, *Hieronymus 245* (CORD[19]). **BOLIVIA. Cochabamba:** Arque, Cerca camino a San Miguel, quebrada Sikipampa, 4000 m, 2 Jan 1992, *no collector, no number* (BOLV); Quillacollo, Town of Tiquipaya, Valley above the Taquiña brewery, 2840 m, 23 Mar 1994, *Ritter 666*, (BOLV); Quillacollo, bosque de *Polylepis* camino Sipe Sipe, Lipichi, 3800 msm, 24 May 1990, *I. Hense 697* (BOLV). **PERU. Ancash:** Huaylas, Huascarán National Park, Quebrada Llaca, NW side of valley 77° 27' W, 9° 27' S, 4400–4600 m, 24 May 1985, *D. Smith et al. 10837* (MO); Quebrada Santa Cruz at base of an entering Quebrada Artizonraju, 77° 36'W, 8° 55'S, 4300–4800 m, 16 Jan 1985, *D. Smith et al. 9303* (MO). **Puno:** Cerro El Calvario, 4000 m, 25 Feb 1965, *A. Arevalo 135* (LIL).

Bromus flexuosus Planchuelo var. **flexuosus** (**Fig. 2A**). Type: ARGENTINA. Catamarca: Pomán, subiendo desde El Rincón rumbo al Cerro Manchado, más arriba de Las Casitas, 2500–2750 m, 19 Feb 1970, *AT Hunziker 20464 A&B* (holotype: CORD!; isotype: US-2669022!).

Distribution and Habitat.—Native in Northwestern Argentina and in the Central Andes region of Bolivia and Peru. It grows in grassland and mountain slopes above 2000 m.

Major references.—Planchuelo (1983); Zuloaga et al. (1994); Gutiérrez and Pensiero (1998); Planchuelo and Peterson (2000); Pavlick et al (2003).

Comments.—The specimen *Peterson & Refulio-Rodriguez 16556* (ACOR, US, USM) was cited for Peru in Saarela et al. (2006) and was the first record of *B. flexuosus* beyond northwestern Argentina where it was originally described.

Representative specimens examined: **ARGENTINA. Catamarca:** Ambato, Sierra de Ambato, (Falda E), Subiendo desde El Rodeo hacia el Cero Manchado, ca. 2900/3100 m, 23/25 Feb 1967, *AT Hunziker 19209* (CORD[07]); Alrededores de Los Cajones, ca 3000 m, 28/30 Jan 1968, *AT Hunziker & Di Fulvio 19709* (CORD[04]). Andalgalá/Pomán, En el altivalle de Las Granadillas, cerca de Belén, 1 Feb 1872, *Lorentz sn*, (CORD[09]); Pomán, subiendo desde El Rincón rumbo al Cerro Manchado, más arriba de Las Casitas, 2500–2750 m, 19 Feb 1970, *AT Hunziker 20464A,B,C* (CORD[A01] US); Alrededores de Las Casitas, frente a El Rincón, ca. 2500 m 20 Feb1970, *AT Hunziker & Ariza 20397* (CORD[05], US). **La Rioja:** Chilecito, camino a La Mexicana, estación 6, 3300 m, 5 Feb 1927, *Parodi 7963* (BAA). Famatina, entre Totoral y Ojo de Agua Superior, 3000 m, 20/21 Mar 1906, *Kurtz 13500* (CORD[11],US); En las cercanías del pié de la cuesta, más arriba del vallecito, 15/20 Jan 1879, *Hieronymus & Niederlein 663* (CORD). Famatina/Chilecito, ca. 2500 m, 21 Jan 1908, *Kurtz 14978* (CORD[08]); La Hoyada, arriba de Vallecito, ca. 2500 m, 22/24 Jan 1908, *Kurtz 14985A,B* (CORD[A03]); same place, in campo castra raro, 22/24 Jan 1908, *Kurtz 14983* (CORD); same place, 31 Jan 1908, *Kurtz 15029* (CORD); Arriba de Vallecito, 2500 m, 3 Feb 1908, *Kurtz 15058* (CORD[10]); La vega de La Hoyada, ca. 2700–2800 m, 17/22 Jan 1908, *Kurtz 15128A*, B (CORD[A06]); same place, 18 Jan 1908, *Leg. J. Jimenez, Kurtz 15138* (CORD). **Tucumán:** Peñas Azules, 3500 m entre San Javier y Amaicha. 27 Jan 1933, *Parodi 10953* (BAA); La Puerta 4000 m, 28 Jan 1933. *Parodi 10893* (BAA). Chicligasta, estancia Las Pavas, 3200 m, 13 Mar 1924, *Venturi 3150* (LIL, US); Puesto La Cascada 2700 m, 13 Mar 1924, *Venturi 3137* (LIL, US). **Salta:** Camino a cuesta del Arca-Trancas. Dec 1896, *Spegazzini 2558* (BAA plants B,C only). **BOLIVIA. Cochabamba:** Cervecería Taquiña. 2570 m, May 1944, *M. Cardenas 3450* (BAA); Quillacollo, Town of Tiquipaya, Valley above the Taquiña brewery, 2840 m, 23 Mar 1994, *Ritter 666* (BOLV). **PERU. Cuzco:** Calca, 22 km N of Calca on road towards Lares, 4120 m, 13°12'56.6"S 71°54'35.2"W, 16 Mar 202, *Peterson & Refulio-Rodriguez 16556* (ACOR[02], US). La Libertad, Hamachuco, Cachipampa, 3150 m, 12 Feb 1948, *Infantes Vera 1968* (BAA). **Junín:** Laguna Tuctuca entre Runotullo y Carrizal, 4200 m, 30 Jan 1953, *C Ochoa 2015* (BAA).

Bromus lanatus Kunth, Nov. Gen. Sp. Pl. 1:150. 1816. (**Fig. 2C**). *Schenodorus lanatus* (Kunth) Roem. & Schult., Syst. Veg. 2:708. 1817. Type: ECUADOR. Pichincha/Napo: Crecit on devexis montis ignivomi Antisanae, *Bonpland s.n.* (holotype: P; isotypes BM; photo K!, US-865493 fragm!).

Bromus oliganthus Pilg., Bot. Jahrb. Syst. 25:718. 1898. Type Protologue: Ecuador. Imbabura: Páramo de Pirán, 4400 msm, *Stübel 61H* (Lectotype, designated here: US-00131962!; isolectotype: US-00081611!), ECUADOR. In paramos montis ignivomi Antisana ad Cerro de la Media Luna, alt. 4400 m, *Stübel 230a* (Syntype: B), ECUADOR. Pichincha. *Stübel 20c* (syntype: B); ECUADOR. In monte ignivomi Puntas, alt. 4400 m, *Stübel 207a* (syntype: B). COLOMBIA. Crescit in monte Tolima ad Boca del Monte, *Stübel 202* (syntype: US)

Perennial. Culms (10–)15–20(–30) cm tall. Leaf sheaths close and retrorsus pubescent to the apex, ligules

membranous glabrous, apex dentate; blades 4–8 cm × 1–3.5 mm, scattered to densely pubescent above and below with long hairs at the margins. Panicles (4–)6–8(–11) cm long, with (4–)5–8(–10) spikelets, branches flexuosus shorter towards the apex, pedicels lanate and flexuosus. Spikelets 13–16 mm long, 4–5(–6)-florets not imbricates with rachilla visible; glumes lance-attenuate, pubescent throughout, densely so near base and margins, first glumes 5–7 mm long, 1-nerved, second glumes 7.5–8.5 mm long, 3-nerved; lemmas 9–11 mm long, oval-lanceolate, 5-nerved, densely pubescent and villous at the base and margins, awns 3–3.5 mm long, subapical. Paleas a little shorter that the lemma; anthers 0.5–0.8 mm long. Caryopsis 6 mm long, widely furrowed, not attached to the lemma and palea.

Distribution and Habitat.—Native to the central Andes. Commonly occurs in grass paramos (treeless alpine plateau, neo-tropical ecosystems) on sandy to rocky slopes and humid places above 2000 m; found in northern Argentina and Chile and especially in Bolivia, Peru, and Ecuador.

Major references.—Standley (1947), Pinto-Escobar (1981, 1986), Matthei (1986), Tovar (1993), Gutierrez and Pensiero (1998), Renvoize (1998), Planchuelo and Peterson (2000).

Comments.—I agree with the original description of Kunth (1816) and with Matthei (1986) that *B. lanatus* has lemmas with five nerves. The observation "lemma 7-nervada" from dry fragments (isotype) of *B. lanatus* by Planchuelo (1983) is erroneous because what was thought to be the two laterals emerging and inconspicuous nerves were the marked crest of the folded lemma base, revealed only after hydrating the materials. The specimen *Spegazzini 2558* from the herbarium BAA has five plants and two panicles mounted in the same sheet. The plant mounted at the left bottom corner, assigned to the letter A is *B. lanatus*, all other plants and panicles correspond to *B. flexuosus* var. *flexuosus*. This important finding indicates that both species share the same habitat in Salta, Argentina. Unfortunately, that region is not well explored and no new specimens have been collected. A similar case of both species sharing the same habitat is seen in three collections of the BAA herbarium by Parodi in "La Rioja, Famatina, Camino a La Mexicana" where the specimen numbered *Parodi 7919* is *B. lanatus*, the specimen *Parodi 7963* is *B. flexuosus* var. *flexuosus* and *Parodi 7976* is *B. flexuosus* var. *famatinensis*.

Representative specimens examined: **ARGENTINA. Jujuy:** Yavi, Cerro Negro 5000 m 1 Apr 1940, *Meyer & Bianchi 14921* (BAA[22]); Tres cruces, camino a pie del puente del Diablo 3700 m, 20 Feb 1959, *Fabris & Marchionni 1791* (BAA[25]). **La Rioja:** Famatina. Camino a La Mexicana, estación 4, 2500 m, 5 Feb 1927, *Parodi 7919* (BAA[23]). **Salta:** Camino a cuesta del Arca-Trancas. Dec 1896, *Spegazzini 2558* (BAA plant A only[26]). **BOLIVIA. La Paz:** Chinchaya, 11 Jun 1959, *Giménez 82* (BAA[24]). Murillo: Valle del Río Zongo, 11 km al norte de la cumbre, puna húmeda 16°13'S, 58°07'W 4100 m, 8 Mar 1987, *Solomon 16302* (BOLV, MO); 14.8 km al N de la cumbre, valle lateral arriba de Laguna Viscachani, 16°12'S, 68°07'W 3900–4000 m, *Solomon et al. 16526*, 11 Abr 1987 (MO[27]); 1 km al N (abajo) de la represa del Lago Zongo, 16°17'S 68°07'W 4600 m, 21 Jan 1987, *Solomon 15821* (BOLV, MO[28]); Ca. 1 km NW of Ovejuyo, 16°32'S, 68°03'W, 3700–3900 m, 2 Apr 1982, *Solomon 7438* (MO[31]). **CHILE. Region I:** 106 km NE of Huara on road towards Colachane, 4340 m, 19°34'53.2"S, 68°58'01.1"W, 26 Mar 2001, *Peterson & Soreng 15651* (MO); 4 km N of Termas Chirigualla SW of Chungará 4720 m, 18°19'42.9"S, 69°08'51.7"W, 4 Apr 2001, *Peterson & Soreng 15760* (MO). **ECUADOR. Azuay:** Páramo de las Cajas, W of Cuenca, 79°14'W, 2°47'S, 4000–4150 m, 2 Sep1984, *Laegaard 52841* (QCA); Laguna Suorococha, 35 km on Cuenca-Molleturo road, 79°14'W, 2°48'S, 4200–4400 m, 30 Jan1988, *Eriksen 2796* (QCA). **Bolivar/Chimborazo:** On road Guaranda/Riobamba, NE of road, 78°50'W, 01°35'S, 4050–4150 m, 10 Jul 1990, *Laegaard 71743* (QCA). **Chimborazo:** Arenal du Chimborazo 4800 m, 13 Nov1988, *Huttel 370* (QCA); surroundings of refugio Whymper, 78°50'W, 01°29'S, 4770–4850 m, 3 Mar1992, *Laegaard 101571* (QCA). **Cotopaxi:** Volcán Cotopaxi. Along the road to and at Limpio Punga, 78°27'W, 0°37'S, 3500–3850 m, 23 Mar 1984, *Laegaard 51861* (QCA); W side of volcán Cotopaxi, above Rancho Santa María, 78°29'W, 00°43'S, 3750–3950 m, 27 May1984, *Laegaard 52203* (QCA); 9 km SW of El Chaupí, on road to base of Illinizas, 4200 m, 1 May1990, *Peterson & CR Annable 8959* (QCA, US); Latacunga-Quevedo road, ca. 28.5 km W of Latacunga, Ca 0°52'S, 78°43'W, 3780 m, 4 April 1992, *Lutayn & Quezada 14391* (MO[30], NY). **Imbabura:** South Western slopes of volcán Cotacachi, 78°21'W, 00°22'S, 4100–4320 m, 9 Nov 1983, *Boysen Larsen et al. 45638* (QCA). **Pichincha:** Reserva Geobotánica Pasochoa, 78°29'W, 00°21'S, 3100–3400 m, 23 Feb 1992, *Laegaard 101409* (QCA); Carretera Pifo-Papallacta, 3 km al oriente de la Ha. Paluquillo, 78°17'W, 00°16'S, 3000 m, 12 Feb 1999, *Terneus & Laegaard 364* (QCA); Highway Quito to Baeza, Papallacta, paramo 3945 m, 1 Dec 1976, *JD Boeke 452* (QCA); Paramo Guamani, W slopes along Quito, Baeza road, 3800–4100 m 0°18'S, 78°14'W, 17 Jan 1981, *Balslev 1609* (QCA). **Pichincha/Napo:** Volcán Antisana, between campamento IMAP, laguna Micacocha, 78°12'W, 00°33'S, 3850–3950 m, 7 Mar 1992, *Laegaard 101608* (QCA); base del volcán Antisana, entrada por Pintag hacia laguna Micacocha, 78°10'W, 00°30'S, 4250 m, 7 Oct 1990 (QCA). **Tungurahua:** Along trail Mesa Tablon to Limpiopungus, S of Lag. Pisayambo, 78°21'W, 01°07'S, 4150–4250 m, 14 Jan 1999, *Laegaard 19467* (QCA); Santiago de Pillaro, Parque Nacional Llanganates, camino desde el Páramo de Soguillas hasta Aucacocha, 01°08'S, 78°19'W 3940 m, 16 Nov 1999, *Narváez et al.* 540 (MO). **PERU. Cajamarca:** Cajamarca-Bambamarca road, in puna 78°33'W, 7°00'S,

3800 m, Rageland, Jalca areas of saturated soil, 17 Feb 1983, *Smith & Vasquez 3483* (MO[29]); 52 km N of Cajamarca on HWY 3, N towards Bambamarca, 3700 m, 16 Mar 2000, *Peterson & Refulio-Rodriguez 14908* (MO). **Cuzco:** Paucartambo, 21 km NE of Paucartambo on road to Tres Cruces, 3460 m, 13°11'54.8"S, 71°38'40.5"W, 18 Mar 2002, *Peterson & Refulio-Rodriguez 16622* (ACOR [20], US). **Tacna:** 7 km NW of Alto Perú on Río Uchusuma, 4330 m, 13 Mar 1999, *Peterson, Refulio Rodriguez & Salvador Perez 14750* (ACOR[21], US).

Bromus modestus Renvoize, Kew Bull. 49:543–546. 1994. (**Fig. 2D**). *Bromus frigidus* Ball, J. Linn. Soc., Bot. 22:63. 1885, *hom. Illeg.* TYPE: PERU: Lima, above Casapalta, *Ball s.n.* (HOLOTYPE: K!; ISOTYPE: US-2858545 frag, ex K!).

Perennial caespitose with the base covered with loose non fibrous sheaths. Culms 10–35 cm tall, with leaves only at the base of the plant. Sheaths often open at middle way, retrorse pilose to sericeus, ligules membranous, glabrous, 1 mm long, apex laciniate. Auricles absent. Blades 3.5–11 cm long × 1–3 mm folder or plane, glabrous, glabrate or scattered to densely pubescent along nerves and margins on both sides. Panicles lax, 3–8 cm long, branches short and flexuosus, with 3–6 spikelets, pedicels flexuosus, glabrous to scabrous, less frequent scattered pubescent. Spikelets 10–15 mm long 3–4(–6)-florets, imbricate. Glumes glabrous, glabrate to scattered pubescent, the first narrowly-triangular 5–7 mm long, 1-nerved, the second lanceolate 7–8 mm long, 3-nerved. Lemma lanceolate, 7–9 mm long, 5-nerved, glabrous or glabrate to scattered pubescent all over and villous only at the base, apex acute; awn subapical, straight 2–3.5 mm long; Palea 6–8 mm long with long hairs on the nerves. Anthers 1 mm long. Caryopsis 6–8 mm long narrowly furrowed attached to the lemma and palea.

Distribution and Habitat.—Native in the Andes, from northern Chile and Argentina northward to Ecuador and Colombia. Grows on mountain slopes and high plains, between 3600–4700 m.

Major references.—Renvoize (1994, 1998); Planchuelo & Peterson (2000).

Comments.—Renvoize (1994) described *B. modestus* by giving a new name to *B. frigidus* Ball. Some authors (Pinto Escobar 1981 and Tovar 1993) considered *B. frigidus* as synonym of *B. pitensis*. Saarela et al. (2007) demonstrated that *B. modestus* and *B. lanatus* formed an exclusive clade in a plastid tree, based on chloroplast and nuclear DNA sequence data, which reaffirms the affinities of both species established by the morphological analysis in this paper. The specimens, *Weberbauer 6902* (US) and *leg. Harlan, US 727045* (US), were cited as *B. lanatus* by Standley (1947), the specimen *Parodi 10854* (BAA, US) was also cited as *B. lanatus* by Gutiérrez & Pensiero (1998) and the specimen Kurtz 1672a (CORD) was cited as *B. flexuosus* in Planchuelo (1983).

Representative specimens examined: **ARGENTINA. Jujuy:** Cochinoca, Laguna Tres Cruces, 14 Feb 1901, *Leg. Claren, Kurtz 1672a; Kurtz 11692* (CORD[35]). **Salta:** Santa Victoria, Abra de Lizoite, 22°13'S, 65°13'W, 4450–4590 m, 8 Mar 2002, *Negrito et al. 408* (CORD[36]). **Tucumán:** Tafí, El Molle, en el camino entre Tafí del Valle y Amaicha, km 91/92, 2800/2900 m, 12 Feb 1986, *AT Hunziker et al. 24893* (CORD[37]); Región montañosa entre San Javier y Amaicha, 4200 m, 30 Jan 1933, *Parodi 10854* (BAA[38], US). **BOLIVIA. La Paz:** Murillo, Valle del Río Zongo, 14.8 km al N de la cumbre, valle lateral arriba de Laguna Viscachani, 16°12'S, 68°07'W 3900–4000 m, 11 Apr 1987, *Solomon et al. 16526* (MO[39]). **COLOMBIA. Caldas:** Cordillera Central, Páramo de Las Letras, ca 370 m, 4 Dec 1958, *Barclay & Juajibioy 6261* (MO). **PERU. Apurimac:** Aymaraes, 22 km NE of Chalhuanca on road towards Yanaca, 4000 m, 14°16'19.8"S, 73°13'07.2"W, 13 Mar 2002, *Peterson & Refulio Rodriguez 16499* (ACOR[32], US). Arequipa: Sumbay, 4000 m, 1909–1914, *Weberbauer 6902* (US). **Ayacucho:** Lucana, 2 km SW of Putajasa. 3900 m, 14°08'15.9"S, 74°11'18.4"W, 24 Feb 2002, *Peterson et al. 16215* (ACOR[33], US); between Huanta and Hacienda Pargora, 4000 m, 2/4 May 1929, *Killip & Smith 23310* (US). **Lagunillas:** Montain crest, 14600 ft, 16 Feb 1914, *leg. Harlan, US 727045* (US). **Puno:** Chucuito, 20 km E of Huacullani on road towards Desaguadero, 3880 m, 5 Mar 1999, *Peterson, Refulio Rodriguez & Salvador Perez 14636* (ACOR[34], US).

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REFERENCES

BURKART, A. 1969. Gramíneas. Flora ilustrada de Entre Ríos (Argentina). Instituto Nacional de Tecnología Agropecuaria, Buenos Aires 6(2):1–551.

Cámara Hernández, J. 1970. *Bromus*. In: A.L. Cabrera. Gramíneas. Flora de la Provincia de Buenos Aires. Instituto Nacional de Tecnología Agropecuaria, Buenos Aires 4(2):85–101.

Cámara Hernández, J. 1978. *Bromus*. In: E.G. Nicora. Gramineae. Flora Patagónica. INTA, Buenos Aires 3:77–93.

Gutiérrez, H.F. and J.F. Pensiero. 1998. Sinopsis de las especies Argentinas del género *Bromus* (Poaceae). Darwiniana 35:75–114.

Hitchcock, A.S. 1927. The grasses of Ecuador, Peru, and Bolivia. Contr. U.S. Natl. Herb. 24(8):291–556.

Kunth, C.S. 1816. *Bromus*. In: A. Humboldt, A. Bonpland, and C.S. Kunth. Nova genera et species plantarum 1. Facsim. ed. Weinheim (J. Cramer) 1963. Pp. 150–153.

Matthei, O. 1986. El género *Bromus* L. (Poaceae) en Chile. Gayana Bot. 43:47–110.

Michener, C.D. and R.R. Sokal 1957. A quantitative approach to a problem of classification. Evolution 11:490–499.

Pavlick, L.E., A.M. Planchuelo, P.M. Peterson, and R.J. Soreng. 2003. *Bromus*. In: R.J. Soreng, P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras, and O. Morrone, eds. Catalogue of New World grasses (Poaceae): IV. Subfamily Pooideae. Contr. U.S. Natl. Herb. 48:154–191.

Pinto-Escobar, P. 1981. The genus *Bromus* in northern South America. Bot. Jahrb. Syst. 102:445–457.

Pinto-Escobar, P. 1986. El género *Bromus* en los Andes Centrales de Suramérica. Caldasia 15(71–75):15–34.

Planchuelo, A.M. 1983. Una nueva especie de *Bromus* (Poaceae) de Argentina. Kurtziana 16:123–131.

Planchuelo, A.M. 1991. Estudios sobre el complejo *Bromus catharticus* (Poaceae), I. Evaluación estadística de los caracteres taxonómicos. Kurtziana 21:243–257.

Planchuelo, A.M. 2009. Nueva distribución de especies de *Bromus* (Poaceae: Bromeae) para la región Centro Andina. Bol. Soc. Argent. Bot. (Supl.) 44(3–4):204–205.

Planchuelo, A.M. 2010. Nuevas citas de especies de *Bromus* L. (Poaceae: Bromeae) para Bolivia. Kempffiana 6(1):3–15.

Planchuelo, A.M. and P.M. Peterson. 2000. The species of *Bromus* (Poaceae: Bromeae) in South America. In: S.W.L. Jacobs and J. Everett, eds. Grasses: Systematics and Evolution. CSIRO, Collingwood, Australia, Pp. 89–101.

Renvoize, S.A. 1994. Notes on *Sporobolus* & *Bromus* (Gramineae) from the Andes. Kew Bull. 49:543–546.

Renvoize, S.A. 1998. Gramíneas de Bolivia. The Royal Botanic Gardens, Kew, U.K.

Saarela, J.M., P.M. Peterson, and N.F. Refulio-Rodriguez. 2006. *Bromus ayacuchensis* (Poaceae: Poideae: Bromeae), a new species from Perú, with a key to *Bromus* in Perú. Sida 22:915–926.

Saarela, J.M., P.M. Peterson, R.M. Keane, J. Cayouette, and S. W. Graham. 2007. Molecular phylogenetics of *Bromus* (Poaceae: Pooideae) based on chloroplast and nuclear DNA sequence data. In: Columbus, J.T., E.A. Friar, J.M. Porter, L.M. Prince, and M.G. Simpson, eds. Monocots: comparative biology and evolution–Poales. Rancho Santa Ana Botanic Garden, Claremont, California. Pp. 450–467.

Sneath, P.H.A. and R.R. Sokal. 1973. Numerical taxonomy: the principles and practice of numerical classification. San Francisco: Freeman.

Standley, P.C. 1947.Gramineae. Grass family. In: Mac Bride, Flora of Perú, Part. I. Field Mus. Nat. Hist. Bot. Ser. 13:115.

Tovar, Ó. 1993. Las Gramíneas (Poaceae) del Perú. Ruizia 13:1–480.

Zuloaga, F.O., E.G. Nicora, Z.E. Rúgolo de Agrasar, O. Morrone, J. Pensiero, and A.M. Cialdella. 1994. Catálogo de la familia Poaceae en la República Argentina. Monogr. Syst. Bot. Missouri Bot. Gard. 47:i–xi, 1–178.

THE GENUS *RYTIDOSPERMA* (POACEAE) IN THE UNITED STATES OF AMERICA

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ABSTRACT

The genus *Rytidosperma* is a group of southern hemisphere grasses in the subfamily Danthonioideae. Several species have been introduced in forage trials into regions of the United States, of which 5 have become naturalized in California, Oregon and Hawai'i in grasslands and ruderal habitats. The species present in the USA are described and new chromosome counts are reported for *R. racemosum* and *R. richardsonii* from California, and *R. caespitosum* from New Zealand.

RÉSUMÉ

Le genre *Rytidosperma* est un groupe de graminées de la sous-famille Danthonioideae de l'hémisphère sud. Plusieurs espèces ont été introduites dans des régions des États-Unis pour essais fourragères, dont 5 ont été naturalisées en Californie, Oregon et Hawaii dans les prairies et les habitats rudérales. Les espèces vivant aux États-Unis sont décrites et le nombre de chromosome est signalé pour *R. racemosum* et *R. richardsonii* en la Californie, et *R. caespitosum* en Nouvelle-Zélande.

INTRODUCTION

Previously included in *Danthonia* sensu lato, *Rytidosperma* is genus of grasses in the subfamily Danthonioideae with about 45 species that are native to Australia, New Zealand, New Guinea, southern South America, and possibly India (Connor & Edgar 1979). Clayton and Renvoize (1986) distinguished *Rytidosperma* from *Danthonia*, but included the African species of *Karroochloa* and *Merxmuelleria* in the former. A narrower generic circumscription of *Rytidosperma* was advocated by Linder & Verboom (1996), who recognized various generic segregates, but acknowledged that "there is an almost equally strong case for recognizing a single, large genus, *Rytidosperma*" (p. 607). According to their interpretation, all species treated here would be placed in *Austrodanthonia* H.P. Linder (Linder 1997, 2005). However, a clear and consistent separation of *Austrodanthonia* from *Rytidosperma* cannot be achieved using the morphological characteristics they provided (cf. Connor & Edgar 1979), and is not supported by the extensive DNA sequence analysis of Pirie et al. (2008). The detailed phylogenetic analysis of Danthonioideae genera by Linder et al. (2010) considers a somewhat intermediate circumscription of *Rytidosperma* approaching that of Clayton and Renvoize (1986) and including all the species treated here. These authors discuss in detail the merits and deficiencies of various options for delimiting *Rytidosperma* and other genera in the Danthonioideae.

Species of *Rytidosperma*, under the names *Danthonia pilosa* and *D. semiannularis*, were imported into New Zealand as seed harvested by mechanical field strippers from natural grasslands in Australia, and sown in seed mixes for grassland improvement (Zotov 1963). They were probably distributed elsewhere in the world for trials. Several species of *Rytidosperma* have been cultivated in research plots or forage trials in both the United States (Weintraub 1953) and Canada under names which are mostly incorrect and for which the original geographic source is obscure (see especially specimens listed under *R. penicillata* below).

J. Bot. Res. Inst. Texas 4(2): 663 – 676. 2010

Naturalization in the US appears to have occurred only in California, Oregon and Hawai'i (Whitney et al. 1939; Darbyshire & Connor 2003; Dean & al. 2008).

The genus *Rytidosperma* is distinguished from *Danthonia* sensu stricto primarily by the presence of transverse rows of hairs on the back of the lemma (Figs. 1–3). These hairs may be in discrete tufts or form more or less continuous lines. One row occurs towards the base just above the callus and the other towards the apex just below the awn sinus. Rows, especially the upper, may be reduced to tufts only at the margins. Other hairs may or may not be scattered across the back of the lemma between the rows. In some species the lemma back indumentum may be lacking altogether, while in other species the lemma back is more or less evenly covered by hairs with no distinct trace of the two rows of tufts. Ensheathed spikelets, cleistogenes, were reported by Chase (1918) in the leaf axils of many species of *Danthonia* (including "*D. semiannularis*"), but these are absent from *Rytidosperma* (Vickery 1956; Connor & Edgar 1979). Florets of the exserted inflorescences may be either chasmogamous or cleistogamous (Edgar & Connor 2000).

Descriptions and measurements given here follow the conventions of Connor & Edgar (1979) and are based primarily on plants of North American and Hawaiian origin. Meiotic chromosome counts of *R. racemosum* and *R. richardsonii* were determined on plants grown from seed obtained from collections originating in California. These counts are indicated in square brackets after the original collection citation. Voucher specimens for chromosome counts of *R. racemosum* and *R. richardsonii* are deposited at DAO with associated material at DAO, CHR and UC. Counts of plants of New Zealand provenance are presented for *R. caespitosum*; vouchers are deposited at AK and CHR. Illustrations of lemmas are prepared from North American (line drawings) and New Zealand (color paintings) material.

This study is primarily focused on species that have become naturalized in the United States; however, a number of specimens of cultivated material are included since undetected escape may well have occurred. Specimens from cultivation were included to improve the species' descriptions, when it was felt that they provide examples of poorly known species, or when they provide information on introduction sites.

TAXONOMIC TREATMENT

Rytidosperma Steud., Syn. Pl. Glum. 1:425. 1854. Type: *Rytidosperma lechleri* Steud.

Notodanthonia Zotov, New Zealand J. Bot. 1:104. 1963. Type: *Notodanthonia unarede* (Raoul) Zotov.
Austrodanthonia H.P. Linder, Telopea 7:269. 1997. Type: *Austrodanthonia caespitosa* (Gaudich.) H.P. Linder.

Plants perennial, densely or loosely cespitose, sometimes shortly rhizomatous. **Culms** (1.5–)30–90(–140) cm, erect or nodding. **Leaves** usually mostly basal; **sheaths** open almost to the base, glabrous or hairy, apices usually with tufts of hairs, sometimes extending across the collar; **ligules** a rim of hairs; **blades** persistent or disarticulating, flat, involute or convolute, glabrous or variously pubescent. **Inflorescences** terminal, racemes or panicles. **Spikelets** somewhat laterally compressed, with 3–10 florets; **florets** bisexual, chasmogamous or cleistogamous, terminal florets reduced; **disarticulation** above the glumes and between the florets; **glumes** (2–)8–20 mm long, subequal or equal, usually exceeding the florets (excluding awns), stiffly membranous, 3–13 veins, usually with scarious margins; **calluses** sharp or somewhat blunt with lateral tufts of stiff hairs, disarticulation oblique; **lemmas** (the main lemma body) ovate to lanceolate, with 2 complete or incomplete transverse rows of tufts of stiff hairs, sometimes reduced to marginal tufts, 5–9(–11) veins, apices bilobed, the **lobes** usually at least as long as the body, acute or acuminate with a long awn-like arista; a central **awn** between the lobes and longer than them, usually proximally twisted below into a column, usually geniculate or reflexed; **lodicules** 2, fleshy, usually with apical hairs or glabrous; **anthers** vary greatly in size depending on whether they are from cleistogamic or chasmogamic flowers (usually $<$ 1.2 mm and $>$ 1.8 mm, respectively). **Caryopses** 1.2–3 mm long, obovate to elliptic, golden to dark brown, free; **hila** punctiform to somewhat elliptic. **Cleistogenes** not formed. $x2 = 12$ (Murray et al. 2005). Name from the Greek *rhytidos*, "wrinkles," and *sperma*, "seed" (vide Connor & Edgar 1979).

KEY TO THE SPECIES OF *RYTIDOSPERMA* NATURALIZED IN THE UNITED STATES OF AMERICA

1. Upper lemma hairs in isolated tufts or at margins only and not forming a continuous transverse row, lower tufts in a continuous row.
   2. Callus of second lemma 0.5–1.5 mm long, its hairs usually overlapping the lower row of lemma hairs; lateral lemma lobes 5–13 mm long, gradually narrowed to a fine awn-like arista _______________ **R. penicillatum**
   2. Callus of second lemma 1–1.5 mm long, its hairs rarely or just reaching lower row of lemma hairs; lateral lemma lobes 5–10 mm long, abruptly narrowed to a fine awn-like arista _______________ **R. racemosum**
1. Lemma hairs in two continuous transverse rows of tufts, with or without hairs between the rows.
   3. Central awn 10–20 mm long, column 4–5 mm long _______________ **R. caespitosum**
   3. Central awn usually less than 10 mm long, column 0.5–3 mm long.
      4. Lemmas 1.8–2.4 mm long; awn column 2.5–3 mm long, distinctly twisted; lower row of lemma hairs usually not reaching upper row _______________ **R. biannulare**
      4. Lemmas 3–4 mm long; awn column 0.5–1 mm long, sparingly twisted; lower row of lemma hairs overlapping upper row _______________ **R. richardsonii**

Rytidosperma biannulare (Zotov) Connor & Edgar, New Zealand J. Bot. 17:324. 1979. (**Fig. 1C, 3B**). *Notodanthonia biannularis* Zotov, New Zealand J. Bot. 1:116. 1963. *Austrodanthonia biannularis* (Zotov) H.P. Linder, Telopea 7:270. 1997. TYPE: NEW ZEALAND. Northland, Waitangi Forest, roadside, abundant, 28 Nov 1953, *V.D. Zotov* (HOLOTYPE: CHR 85021).

Danthonia semiannularis auct. amer., non (Labill.) R. Br.

Plants caespitose. **Culms** 30–85 cm, erect, smooth and glabrous, glabrous below inflorescence, branching intravaginal. **Leaves** mostly basal, exceeded by the culms, flag leaf blades usually reaching or exceeding the inflorescences; **sheaths** mostly glabrous, often purplish distally, apical tufts of hairs to 5 mm or sometimes absent; **ligules** 0.3–0.5(–1) mm; **blades** 30–40 cm long, to 5 mm wide, usually involute, margins, apices, and sometimes adaxial surfaces scabrous, young blades sparsely pilose, becoming glabrous at maturity. **Inflorescences** paniculate, 10–20 cm long, narrow and compact; **rachis** scabrous; **pedicels** shorter than spikelets, scabrous. **Spikelets** (7–)10–15 mm long, with 6–7 florets; **glumes** 7.5–11(–13.2) mm long, surpassing florets, subequal, lanceolate, acute, glabrous, light green to stramineous usually purple at margins and apex; **lower glumes** 5–7(–9) veins; **upper glumes** 5 veins; **rachilla segments** 0.3–0.5 mm long; **calluses** 0.5–0.7 mm long, hairs to about 1 mm and reaching the lower lemma hairs; **lemmas** 1.8–2.4(–2.8) mm long, hairs of lower row usually not or only just reaching the upper row, lower row sometimes ill-defined, hairs of upper rows reaching or surpassing the awn column apex but not the apex of the lemma lobes, with short scattered hairs (rarely glabrous) between the rows; **lobes** 3.5–5(–8.5) mm long, acuminate; **awn** 6–10(–12.5) mm long, twisted column 2.5–3 mm long; **paleas** 2.5–4.6 mm long, exceeding the lemma sinuses, obovate, emarginate, sparsely hairy between the veins, margins usually with long hairs, veins ciliate; **anthers** 0.8–1.6 mm long. **Caryopses** 1.2–1.9 mm × 0.6–0.8 mm; **embryos** 0.5–0.8 mm long; **hila** 0.3–0.6 mm long. $2n$ = 48; New Zealand plants (Murray et al. 2005).

A single collection from southwestern Oregon (*Peck 23954*) and another from Maui (*Hobdy 2389*) provide the only evidence that this species may have naturalized in the United States, although cultivated specimens from Santa Cruz Co., California, have also been seen (Fig. 4A). The species has been grown experimentally in North America under the name *Danthonia semiannularis* (Labill.) R. Br., possibly as early as 1905 (Weintraub 1953). However, as pointed out by Vickery (1956), *D. semiannularis* is a name that "has been used for almost any but the true species" and more than one species was probably imported to North America under this name. Since tetraploid *R. biannulare* is regarded as native to New Zealand and unknown in Australia, this species may have been more recently introduced than the early 20th Century importation of Australian species.

Whitney et al. (1939) and Wagner et al. (1999), respectively, reported *R. semiannulare* as introduced to the state of Hawai'i (on Molokai) in 1903 and first collected (on Maui) in 1937. The 1937 specimen (*Hosaka 1767*) is, however, referred to *R. caespitosum*. Label data on a relatively recent collection of *R. biannulare* from West Maui (*Hobdy 2389*) suggest that this species has naturalized there.

Specimens examined: **CALIFORNIA. Santa Cruz Co.:** Ives plots near Aptos, Corralitos area, [cultivated], 20 May 1940, *P.B. Dickey 920*,

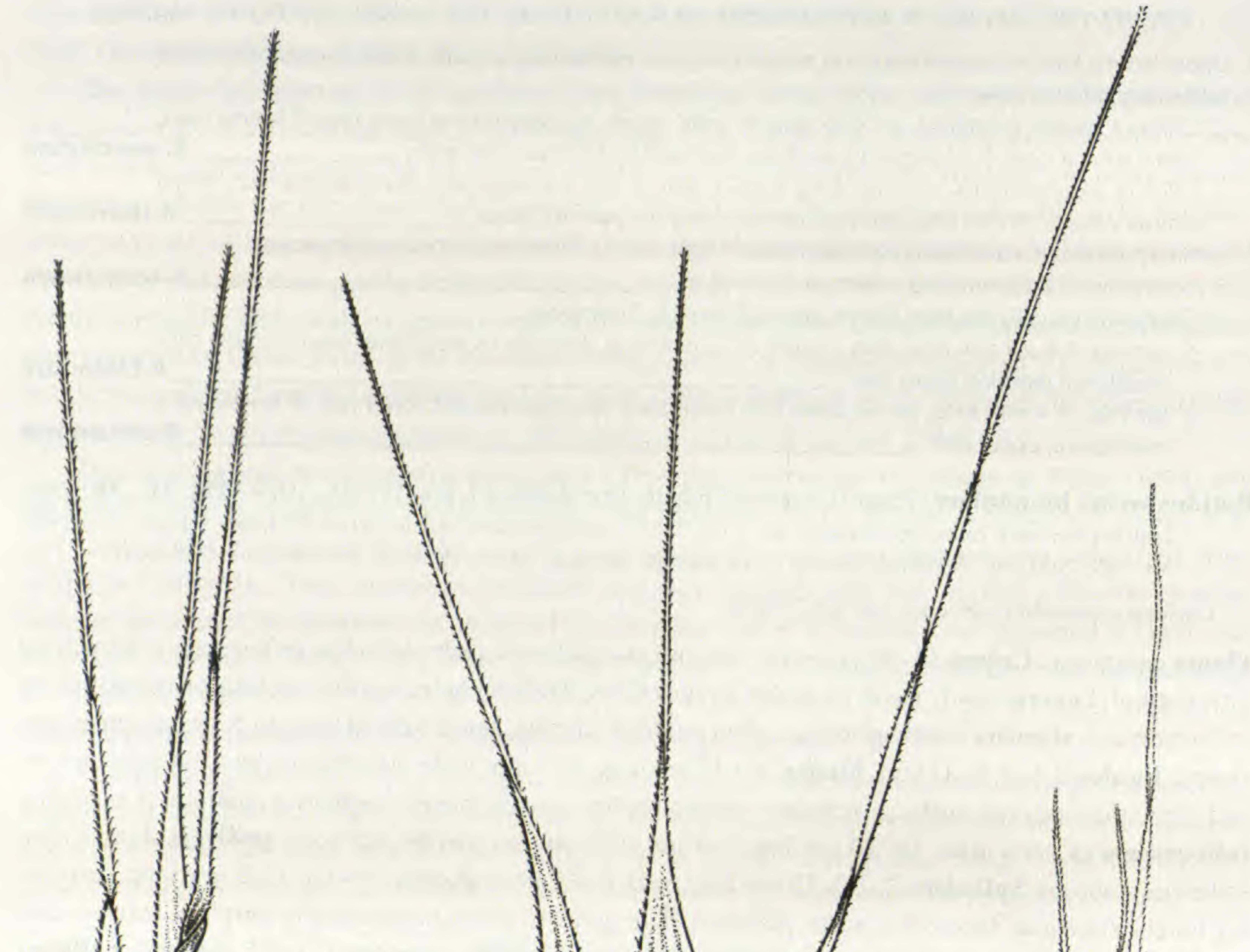

Fig. 1. Lemmas of *Rytidosperma*. A. *R. penicillatum*. B. *R. racemosum*. C. *R. biannulare*.

D920 (AHUC, US). **HAWAI'I. Maui:** West Maui, Hanaulaiki, elev. 3500 ft, May 1985, *R. Hobdy 2389* (BISH). **OREGON. Curry Co.:** 5 mi S of Gold Beach, shady bank, 23 Jul 1945, *M.E. Peck 23954* (WILLU).

Rytidosperma caespitosum (Gaudich.) Connor & Edgar, New Zealand J. Bot. 17:325. 1979. (**Fig. 2B, 2C, 3C**). *Danthonia caespitosa* Gaudich. in Freycinet, Voy. Uranie Bot. 408. 1829. *Notodanthonia caespitosa* (Gaudich.) Zotov, New Zealand J. Bot. 1:117. 1963. *Austrodanthonia caespitosa* (Gaudich.) H.P. Linder, Telopia 7:271. 1997. Type: AUSTRALIA. Western Australia: Nouveau Hollande, Baie des C[hiens]-Marins [Shark's Bay], *C. Gaudichaud-Beaupré* (holotype: P; isotype: K, BM).

Danthonia varia Nees, London J. Bot. 2:416. 1843. *Danthonia semiannularis* var. *varia* (Nees) Domin, Biblioth. Bot. 20(85):363. 1915. Type: AUSTRALIA. Western Australia: Swan River, 1839, *J. Drummond 161*. (lectotype: CGE; isolectotype: BM, K, NSW).

Plants densely to loosely caespitose, sometimes shortly rhizomatous. **Culms** 43–80 cm, erect, smooth and glabrous, glabrous or sparsely scabrous immediately below the inflorescence, branching intravaginal (or rarely extravaginal). **Leaves** mostly basal, usually exceeded by culms, flag leaves sometimes reaching inflorescence; **sheaths** glabrous or pilose, apical tufts of hairs 1–4 mm long, sometimes scanty; **ligules** (0.3–)0.5–1.2 mm long; **blades** 6–25 cm long, 1.5–3 mm wide, involute or more or less flat, glabrous or variously pubescent. **Inflorescence** paniculate, 5–11 cm long, linear to ovate, more or less compact; **rachis** scabrous to somewhat pubescent; **pedicels** shorter than spikelets, scabrous to somewhat pubescent. **Spikelets** 10–20 mm long, 4–9 florets; **glumes** 9–18(–20) mm long, surpassing florets, subequal to unequal, lanceolate, acuminate, glabrous or sometimes with scattered long hairs, light green to stramineous often purple at margins and apex; **lower glumes** (1–)3–5(–7) veins; **upper glumes** (3–)5–7(–9) veins; **rachilla segments** 0.1–0.4 mm long; **calluses** 0.4–1.5 mm long, hairs to about 1.5 mm long and usually reaching lower lemma hairs; **lemmas** 2.3–4 mm long, hairs of lower row to about 1.5 mm long and reaching the upper row, hairs of upper row to about 3.5 mm long and reaching or surpassing the palea apex but not apex of awn column or lemma lobes, glabrous between the rows; **lobes** (6–)7–10 mm long, acuminate or aristate; **awn** 10–20 mm long, tightly twisted column 4–6 mm long; **paleas** 2.5–5.5 mm long, surpassing lemma sinus, lanceolate to obovate, emarginate, glabrous between the veins, margins with a few long hairs, veins ciliate; **anthers** 0.5–2.6 mm long. **Caryopses** 1.7–2.3 mm × 0.8–1.1; **embryos** 0.7–1 mm long; **hila** 0.25–0.7 mm long. $2n = 24, 48, 72$; Australian plants (Abele 1959; Brock & Brown 1961; Waters et al. 2010). $2n = 24$; New Zealand plants (B.G. Murray & J.P. de Lange, hic comm.; AK 25913C, CHR 549710).

Grasslands, pastures, rangelands and disturbed areas up to 200 m. A highly variable and widespread species with co-occurring polyploid races indigenous to southern Australia (Vickery 1956; Abele 1959; Brock & Brown 1961; Waters et al. 2010). *Rytidosperma caespitosum* has naturalized at a few scattered locations in California (Berkeley, Pescadero and San Diego regions), and has been cultivated at Pullman, WA, and several sites in California (Fig. 4B). Two collections form Hawai'i by Hosaka in the 1930s are referred to this species, but the lack of recent collections suggests that it may not have persisted. It has also been naturalized in New Zealand since at least 1892 (Zotov 1963). It is listed, with some uncertainty, among the species introduced to the United Kingdom through discarded wool-waste (Lousley 1961; Ryves 1988).

Specimens examined: **CALIFORNIA. Alameda Co.:** Berkeley, grass garden, [cultivated], T.O. 600, SPI 54736, 24 May 1926, *J.A. Denny s.n.* (AHUC); Berkeley, Oxford Tract, [cultivated], 15 Jun 1929, *B.P. Kennedy s.n.* (AHUC); Pleasanton, [cultivated], origin: Australia, New South Wales, P.I. 238-283, T.O. 2512 raised at the SCS Plant Materials Center (No. PL 58-58), 19 Oct 1959, *B. Crampton s.n.* (AHUC); mouth of Strawberry Canyon in Oakland/Berkeley hills, east side of UC campus, southwest slope overlooking stadium ("Tightwad Hill"), southwest facing slope, grassland just below eucalyptus grove and above pines, 16 Feb 2002, *B. Ertter 17815* [p.p.] (DAO, UC); Berkeley, NW edge of Strawberry Canyon on E edge of main UC campus, NE of main "viewing area" for "Tightwad Hill" overlooking football stadium, E side of eucalyptus grove, 26 Jun 2003, *B. Ertter 18231a* (CHR, DAO, UC). **Butte Co.:** Chico, [cultivated], S.P.I. No. 17205, seed from Richmond, New S. Wales, H.W. Potts 1-20-06, 7 Sep 1910, *C.V. Piper s.n.* (US). **San Diego Co.:** Lusardi Creek MSCP parcel: ridges S of Lusardi Creek, 0.6 km NNE Low South Survey Marker, T13S, R3W, SW/4 SW/4 sect. 26, rocky ridge on cobbly clay in openings of chamise chaparral, with *Adenostemma fasciculatum*, *Lotus scoparius*, *Mimulus puniceus* and *Mirabilis californica*, alt. 93 m, UTM 11S 0484470 m E 3651910 m N, clumped perennial, culms to 0.4 m tall, locally common, 18 Apr 2001, *F.M. Roberts 5434* (RSA); near Fairbanks Ranch, ridge S of Lusardi Creek, ca. 0.2 km north San Dieguito Rd. and 1.3 km NE Fairbanks Lake, Rancho Santa Fe Z11S 0484468 mE, 3651734 mN, southeast-facing slope on clay soil in mixed grassland bordering coastal sage scrub, associated with *Stipa pulchra*, *Avena barbata*, *Vulpia myuros*, *Erodium cicutarium* and *Artemisia californica*, bordering fresh grading, alt. 83 m/ft [sic], 29 Mar 2005, *F.M. Roberts 6136* (UCR). **San Mateo Co.:** Santa Cruz Mountains, Cascade Ranch State Park, between Whitehorse Creek and Cascade Creek, 4 Aug 1992, *G. Clifton s.n.* (UC). **Yolo Co.:** Agronomy Experimental Areas, Davis Campus, T.O. 2512, Row E-40, [cultivated], origin: Australia, New

Fig. 2. Lemmas of *Rytidosperma*. A. *R. richardsonii*. B. *R. caespitosum* (Berkeley). C. *R. caespitosum* (San Diego).

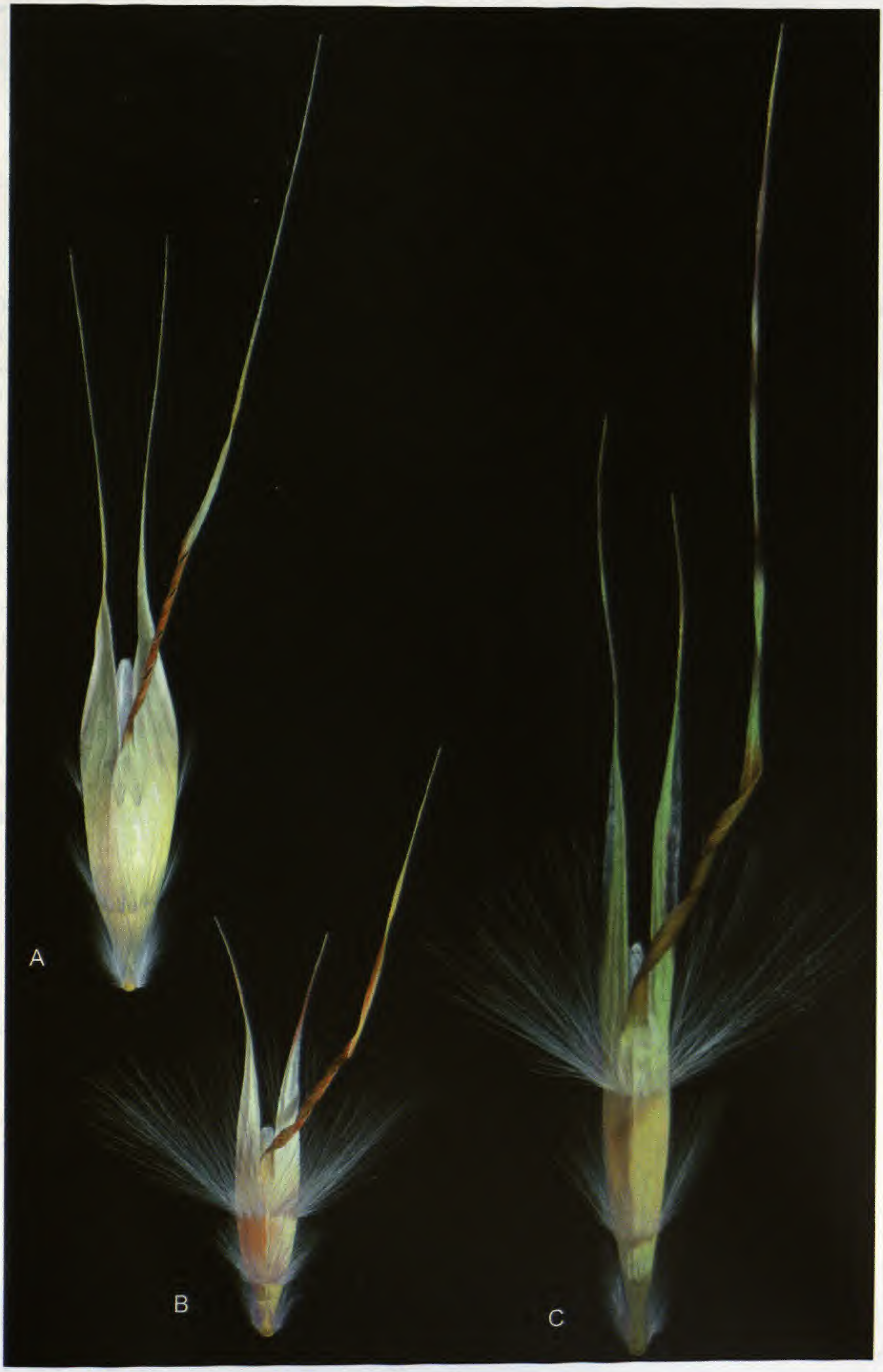

Fig. 3. Lemmas of *Rytidosperma*. **A.** *R. penicillatum*. **B.** *R. biannulare*. **C.** *R. caespitosum*.

South Wales, P.I. 238-283 thru SCS Plant Materials Center, Pleasanton (PL 58-58) 1959, 7 May 1962, *B. Crampton s.n.* (AHUC). **HAWAI'I. Maui:** Haleakalā, Puu Nianiau, common in open pasture, alt. 6000 ft, 28 Jan 1937, *E.Y. Hosaka 1767* (BISH); Haleakalā, Makawao, common in grassy slope among *Styphelia*, elev. 5000 ft, 12 Apr 1939, *E.Y. Hosaka 2472* (BISH). **WASHINGTON. Whitman Co.:** Pullman, [cultivated], S.P.I. No. 17203, seed from Richmond, New S. Wales, H.W. Potts 1-20-06, 1907, *C.V. Piper s.n.* (US).

Rytidosperma penicillatum (Labill.) Connor & Edgar, New Zealand J. Bot. 17:327. 1979. (**Fig. 1A, 3A**). *Arundo penicillata* Labill., Nov. Holl. Pl. Spec. 1:26, t. 34. 1805. *Danthonia penicillata* (Labill.) P. Beauv., Ess. Agrostogr. 153, 160. 1812. *Danthonia racemosa* var. *penicillata* (Labill.) Benth., Fl. Austral. 7:594. 1878. *Notodanthonia penicillata* (Labill.) Zotov, New Zealand J. Bot. 1:122. 1963. *Austrodanthonia penicillata* (Labill.) H.P. Linder, Telopia 7:272. 1997. TYPE: AUSTRALIA. TASMANIA: Habitat in capite Van Diemen, *Labillardière* (HOLOTYPE: FI-W; photo K).

Danthonia pilosa auct. amer., non R. Br.

Plants densely to loosely caespitose to somewhat spreading, shortly rhizomatous. **Culms** (22–)30–90 cm, erect, usually smooth and glabrous, usually scabrous-pubescent immediately below the inflorescence, branching extravaginal, cataphylls scaly. **Leaves** mostly basal and greatly exceeded by the culms, flag leaf blades usually not reaching the inflorescence; **sheaths** densely hairy or glabrous, apical tufts of hairs 1–3.5 mm long; **ligules** (0.1)0.3–1 mm long; **blades** to 30 cm long and to 5 mm wide, flat, folded, or involute, glabrous, scabrous or pubescent. **Inflorescences** racemose or paniculate, (3–)4–10 cm long, ovate to linear, compact; **rachis** scabrous to finely pubescent; **pedicels** shorter than the spikelets, glabrous, scabrous or finely pubescent. **Spikelets** 9–15(–18) mm long, 5–7(–10) florets; **glumes** (7.5–)8–13(–17.5) mm long, surpassing florets, subequal, lanceolate, glabrous, scabrous, or sometimes with scattered hairs, light green to stramineous often purple at margins and apex; **lower glumes** 5–9(–11) veins; **upper glumes** 5–7(–9) veins; **rachilla segments** 0.2–0.5 mm long; **calluses** 0.5–1.3 mm long, hairs about 1.5 mm long and usually reaching the lower lemma hairs; **lemmas** (2–)2.5–4.2 mm long, 9(–11) veins, lower row of hairs continuous or with weak (rarely absent) central tufts, hairs of the marginal tufts usually reaching the upper row of hairs, upper row of hairs composed of 2 marginal tufts, sometimes with 2 additional scanty tufts between, hairs reaching or slightly exceeding the base of the awn, otherwise glabrous; **lobes** 5–11(–13) mm long, acuminate, aristate; **awn** (7–)9–17.5 mm long, tightly twisted column 1.5–4 mm long, somewhat reflexed at base and revealing palea apex or not; **paleas** 3–6 mm long, exceeding the lemma sinuses, emarginate, intercostal region glabrous or scabrous, margins glabrous or with sparse long hairs, veins ciliate; **anthers** 0.4–2.7 mm long. **Caryopses** 1.8–2.5(–3) mm × 0.8–1.1(–1.6) mm; **embryos** 0.7–1(–1.5) mm long; **hila** (0.3–)0.4–0.5(–0.7) mm long. $2n = 24$; Australian plants (Abele 1959; Brock & Brown 1961) and Californian plants (Myers 1947 [as *Danthonia pilosa*]).

Commonly growing on dry, nutrient-poor soils. Habitats include pastures, rangelands and disturbed areas at elevations up to about 800 m in California, and about 1675–2840 m in Hawai'i. It is a common weed in coastal regions of California and southwestern Oregon (Fig. 4C). At best, only of moderate forage value in the United States where it is usually considered a troublesome pest competing with more desirable species (Murphy & Love 1950; Stone et al. 1992).

An Australian species, *R. penicillata* has been incorrectly known in the United States for many years under the name *Danthonia pilosa* R. Br. (e.g., Hitchcock 1951; Sampson et al. 1951; Weintraub 1953). Various common names have been used, including hairy danthonia, hairy oatgrass, Australian oatgrass and poverty grass. Although it is considered a poor quality forage grass, it was introduced and tested in the continental states in 1911 and again in 1921 (Weintraub 1953). By the 1940s it had become a troublesome weed at scattered localities mainly in coastal areas from southwestern Oregon to central California (Murphy & Love 1950; Sampson et al. 1951). Introduced to the Hawaiian Islands about 1910 (Whitney et al. 1939; BISH 624327) and to New Zealand as early as 1840 (Zotov 1963), it is now well established in these regions. In the United Kingdom, it has been reported as introduced with wool-waste (Lousley 1961; Ryves 1988), but has not become fully naturalized (Stace 1997).

Specimens examined: **CALIFORNIA. Alameda Co.:** Berkeley, [cultivated], experimental plot planted 1914, seed from Brunning Co., Australia, 16 Jul 1916, *P.B. Kennedy s.n.* (AHUC); Berkeley, campus, [cultivated], seed collected at Davis, Calif., 9 Jul 1920, *P.B. Kennedy 3073* (AHUC, DAO), *3389* (AHUC, DAO); Berkeley, Cragmont Park, from lawn where growing as weed, an aggressive weed, hard to

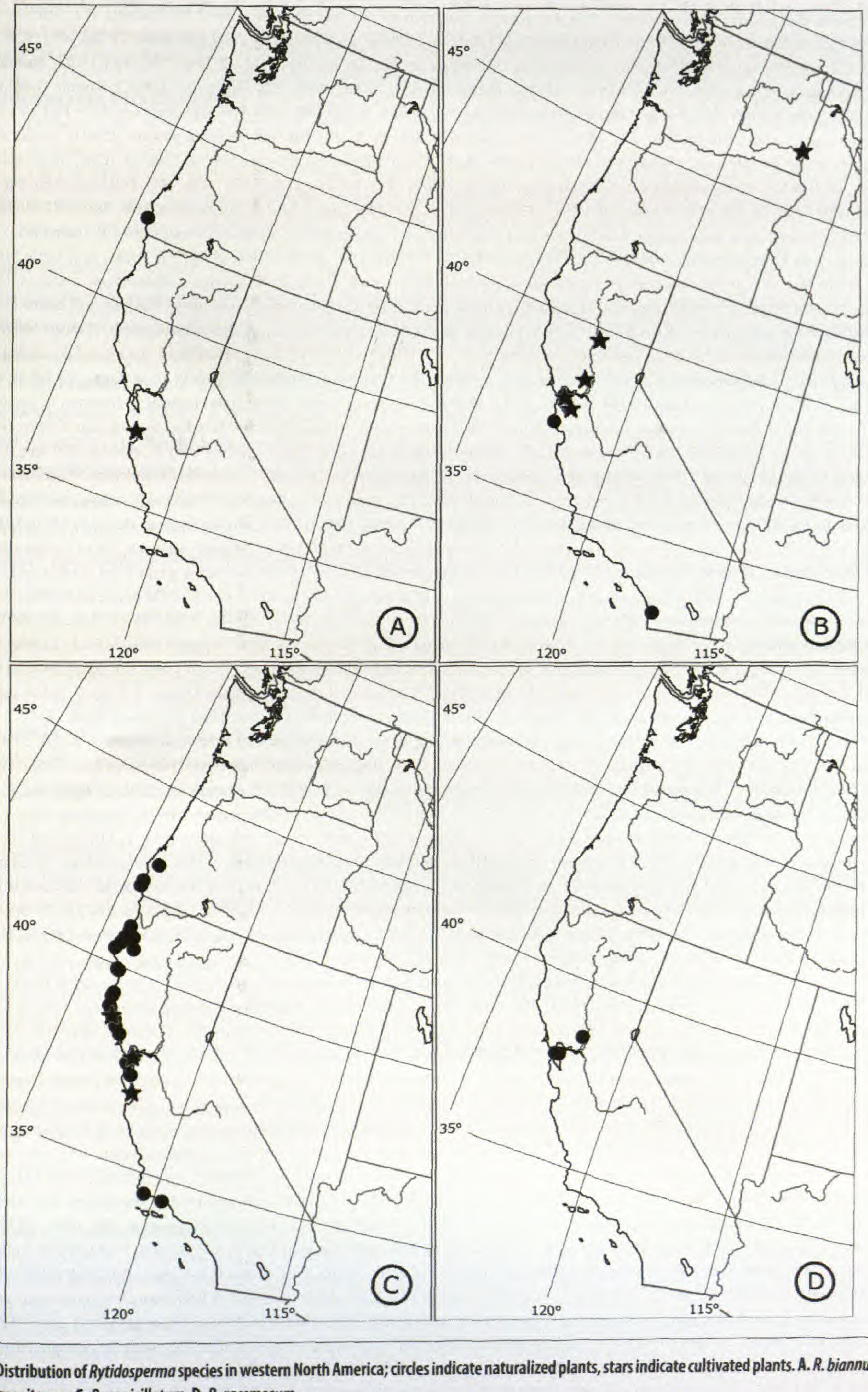

Fig. 4. Distribution of *Rytidosperma* species in western North America; circles indicate naturalized plants, stars indicate cultivated plants. A. *R. biannulare*. B. *R. caespitosum*. C. *R. penicillatum*. D. *R. racemosum*.

control particularly where lawn is watered little, horticulture specimen no. 20, Jun 1950, $2n = 24$ (J.M.J. DeWet), *G.L. Stebbins 3202* (AHUC, UC); Berkeley, campus of Univ. of California, N of Life Sciences Bldg., growing under *Eucalyptus* trees, 11 Sep 1952, *R.W. Pohl 7201* (CAS); north Berkeley, weedy sites in residential area, including as weed in lawns, 19 Jul 2000, *B. Ertter 17419* [p.p.] (UC). **Humboldt Co.:** Loleta, coast, 6 Aug 1938, *B.A. Madson s.n.* (AHUC); Ureka [Eureka], 15 Aug 1940, *H.B. Shontz s.n.* (AHUC); Bayside Golf Links, elev. 100 ft, probably introduced in grass seed mixture, forming a close turf, 16 Jun 1941, *Mrs. Wm. Grotzman s.n.* (UC); Patrick's Point State Park, open meadow, 28 Jul 1941, *F.W. Peirson 13113* (RSA); at Hungry Hollow on Bald Mt., in sheep pasture, 2500 ft, locally abundant as if a recent introduction, 17 Aug 1941, *J.P. Tracy 16994* (AHUC, UC); Bald Mountain, Mar 1942, *J. Tracy s.n.* (CAS); near "Hungry Hollow" on Bald Mt., locally abundant in sheep pasture, 2000 ft, 28 Jun 1942, *J.P. Tracy 17267* (DS, HSC, MO, POM, UC, US); Parrott's Ranch, Table Bluff, ca. 1.5 mi N of Loleta, Jun 1947, *A.H. Murphy s.n.* (AHUC); Loleta, Patrick's Point State Park, July 1947, *R. Tofsrud 200* (AHUC); near Angels Ranch on the Bald Mt., road at Hungry Hollow, in sheep pasture, 2500 ft, 11 Aug 1949, *J.P. Tracy 18451* (UC); Bear River, 3 mi E of Capetown, 19 Jul 1956, *R. Evans s.n.* (AHUC); T 3 N, R 1 W, Sec. 16, about 20 mi S of Arcata near Little Salmon Creek on the Marvin Stapp Ranch, open grassy pasture below the house, elev. ca. 150 ft, assoc. species: *Anthoxanthum aristatum*, *Holcus lanatus*, *Prunella vulgaris* and *Rubus procerus*, 24 Jun 1967, *T. Hoyle 261A-67* (HSC); Humboldt State College Campus, just below Founder's Hall, near the steps to the Science Bldg., T 6 N, R 1 E, Sec. 28, cultivated lawn, assoc. species *Holcus lanatus*, *Plantago lanceolata*, *Trifolium repens* and other cultivated grasses, elev. ca. 100 ft, 5 Jul 1967, *T. Hoyle 274-67* (HSC); Trinidad Head, large coastal rock outcrop, *Smith 12151* (HSC). **Mendocino Co.:** near Pt. Arena, open woods, 7 Jul 1938, *W.A. Silveus 2935* (DAO); Point Arena, 15 Jul 1941, *D. Jensen s.n.* (DAV); Point Arena, August 1949, *W.H. Brooks 111* (AHUC); ½ mi N of Albion, along State Highway 1, common in patches in grazed coastal mesa flats, surrounding area boggy, 26 Jul 1955, *B. Crampton 3041* (AHUC); city of Mendocino, common in open coastal mesa above sea, 27 Jul 1955, *B. Crampton 3128* (AHUC); on Orr Spring Road, 1.7 mi E of California Hwy. 1, elev. ca. 550 feet, 25 Jun 1964, *R.E. Frenkel 625* (CAS); 4.5 mi S of Mendocino, State Hwy. 1, 29 Jun 1966, *B. Crampton 7792* (AHUC); Sinkyone Wilderness State Park, T23N R18W SW ¼ Sec. 22, Hales Grove, 7.5" USGA quad, about 10 mi due W of Leggett and 60 mi N of Fort Bragg, mouth of Usal Creek on the Pacific Ocean, flood plain, coastal prairie, disturbed by livestock grazing and upstream logging, elev. 0 ft, 19 Jul 1988, *F. Bowcutt 1146* (HSC); Sinkyone Wilderness State Park, T24N R19W SE ¼ Sec. 9, Bear Harbor 7.5 Quad., 15 air mi SW of Garberville, 60 air mi SSE of Eureka, ⅛ mi SE Jone Beach, 1.25 mi SW Four Corners, coastal grassland of marine terrace, grazed and used as dairy farm prior to State acquisition with periodic prescribed burns, W aspect 10 slope, elev. 140 ft, 50.75 yds W of old homesite at Jones Ranch, associated with *Holcus lanatus*, *Linum*, *Plantago lanceolata*, *Erechtites*, *Senecio jacobaea*, *Rubus vitifolius*, 7 Jul 1989, *F. Bowcutt 1366* (DAV, HSC). **Santa Barbara Co.:** Santa Barbara Coastal Plain region, coastal plains & basins, in lawn of upper Hillside Park, 13 May 1947, *C.F. Smith 2009* (AHUC, CAS, RSA, US); Santa Ynez Mts, Hillside Park [upper], Santa Barbara, 22 Jul 1949, *C.F. Smith 2406* (AHUC, SBBG); Santa Ynez Mts, San Augustin Cyn, Cuesta Rd on Hollister Ranch, ca. N of San Augustin Arroyo, *C.F. Smith 12686* (SBBG). **Santa Clara Co.:** Palo Alto, University Ave. at Chaucer St., uncultivated in parking area, 29 Jun 1960, *J.T. Howell 35482* (AHUC, CAS, DAV, DS); Palo Alto, Chaucer St. and University Ave., in weedy parking lot between sidewalk and street at intersection, 30 Jun 1960, *J.H. Thomas 8808* [DS, RSA); Palo Alto, wasteland, *J.T. Howell s.n.* (AHUC, JEPS). **Santa Cruz Co.:** near Aptos, Ives plots, [cultivated], 20 May 1940, *P.B. Dickey D921* (US). **Sonoma Co.:** Gualala, experimental plots, [cultivated], 1915, *P.B. Kennedy s.n.* (AHUC); Miller Ridge, open grassland in redwood belt with *Bromus mollis* etc., 2 Jul 1957, *J.C. Roos 6651* (CAS, RSA, UCR); Stewart's Point, along State Hwy 1, 2 mi N, slopes above sea, below bishop pine forest, 22 Jul 1957, *B. Crampton 4358* (AHUC, UC); along State Hwy. 1, 11.7 mi S of Stewart's Point, slopes above the sea, 22 Jul 1957, *B. Crampton 4392* (AHUC); Sea Ranch, near State Highway 1, Unit 1 Owner's Map, tufted perennial, 50 feet back from ocean bluffs, 24 Jun 1974, *M.M. Hektner & C. Hendel 068* (DAV); 3.1 mi N of Fort Ross Road, on Seaview Road, elev. 1300 ft, 23 Jun 1964, *R.E. Frenkel 623* (CAS); Annapolis Road area just below and W of landing strip at the Sea Ranch, disturbed sites in annual grassland, elev. ca. 300 ft, 30 Nov 1980, *R.D. Stone 332* (JEPS); The Sea Ranch, 2 Aug 1981, *M.P. Wells s.n.* (CAS); The Sea Ranch, Timber Preserve of Oceanic of California Inc., 3 Aug 1983, *M.P. Wells s.n.* (CAS); Bodega Bay, behind community center on W side of Hwy 1 N of town, coastal meadow, locally abundant, in patches, with *Briza maxima*, 19 Jul 2003, *B. Ertter 18246* (CHR, DAO, UC). **Yolo Co.:** Davis, grass garden, [cultivated], 13 Jun 1919, *Leonard 3073* (AHUC). **HAWAI'I. Hawai'i:** Mauna Kea, Pohakaloa [Pohakuloa] Military Camp, site B-2, T-1, #5, 1979 burn area, elev. 8000 ft, *K. Adee s.n.* (BISH); North Hilo, Humuula, near Puu Oo, fairly wet pasture, elev. 7000 ft, 2 May 1932, *G.R. Ewart III 250* (BISH); slope above Humuula, 7000–7500 ft, 30 Jul 1935, *E.H. Bryan, Jr. s.n.* (BISH); Kaohe, Mauna Kea, Hamakua, occasional in dry open pasture, elev. 6500 ft, 12 Sep 1936, *E.Y. Hosaka 1596* (BISH); North Hilo, Humuula Sheep Sta., elev. 6700 ft, 13 Jun 1938, *E.Y. Hosaka 2316* (BISH); near Pohakuloa, Puu Omaokoili, elev. 7000 ft, 3 Apr 1962, *E. Kosaka* [sic] *12* (BISH); on road from saddle (Humuula Sta.) to State Park cabins (Halepohaku), S slope of Mauna Kea volcano, tussock grassland (*Deschampsia nubiginea*, *Trisetum glomeratum*, *Danthonia* sp., many spp. intro.) *Sophora chrysophylla* savanna, on porous basaltic sands and volcanic ash slopes, elev. 8200–9200 ft, 23 Jun 1967, *H.H. Iltis & C.M. Iltis H-190* (RSA), *H-190a* (BISH); Puu Laau, weed growing near the hunter's cabin, elev. 7450 ft, 18 Jan 1975, *D. Herbst 5224* (BISH); saddle area along road to Mauna Loa observatory, ½ mi from Pu'u Huluhulu, growing with *Juncus*, *Tetramolopium*, *Vaccinium* and grasses near native scrub vegetation, elev. 6500–7000 ft, 15 Jun 1981, *J. Davis 523* (BISH); N slope of Mauna Kea, Makai of Puu Kole near Hanapoe Gulch, 19°53'25"N, 155°27'18"W, subalpine shrubland with cinder substrate, associated vegetation Pukiawe, mamane, 23 Jul 2004, *F. Starr & K. Starr 040723-9* (BISH). **Maui:** Haleakalā nusery, volunteer, 13 Sep 1938 (BISH); west rim of Haleakalā Crater, alpine grassland at Kalahaku Overlook, weeds and occasional native grasses along road, foot path and *Argyroxiphium sandwicensis* (Silversword) enclosure, alpine grassland, elev. 9320 ft, 7 Aug 1967, *H.H. Iltis & C.M. Iltis H-543* (RSA); Haleakalā Crater, base of Crystal cave, on open cinder slope with *Deschampsia*, *Styphelia*, *Sophora*, elev. 2195 m, 25 Jun 1998, *B. Haus s.n.* (BISH); on side of Crater Rd., 20°45'N, 156°16'W, pastures, *Pennisetum clandestinum*, elev. 5500 ft, 13 Sep 2000, *F. Starr & K. Martz 000913-3* (BISH); Makawao Dist., Kamaole, Kula Forest Reserve, alongside the Haleakalā Ridge

Trail, 20°40'N, 156°20'W, alien forestry plantings, elev. 6300 ft, 15 Jul 2002, *H.L. Oppenheimer et al. H70208* (BISH). **OREGON. Curry Co.:** 5 mi S of Gold Beach, grassy slope, 23 Jul 1945, *M.E. Peck 23955* (WILLU); Pistol River State Park, on coastal dunes, with *Phacelia argentea*, 28 Jul 1982, *J. Kagan 728822* (OSC). **Coos Co.:** Gaylord, growing in a hill pasture, 22 Aug 1956, *J.R. Thienes s.n.* (OSC).

Rytidosperma racemosum (R. Br.) Connor & Edgar, New Zealand J. Bot. 17:327. 1979. (**Fig. 1B**). *Danthonia racemosa* R. Br., Prodr. 177. 1810. *Danthonia penicillata* var. *racemosa* (R. Br.) Rodway, Tasmanian Flora 267. 1903. *Notodanthonia racemosa* (R. Br.) Zotov, New Zealand J. Bot. 1:121. 1963. *Austrodanthonia racemosa* (R. Br.) H.P. Linder, Telopea 7:273. 1997. Type: AUSTRALIA. New South Wales: Port Jackson, 1802–1805, *R. Brown 6235*. (holotype: BM; isotype: K; fragments: CHR, MEL, PERTH).

Danthonia pilosa var. *racemosa* Buchan., Indig. Grasses New Zealand t. 33(2) B. 1879. Type: NEW ZEALAND: [probably] Wellington, summer 1878–1879, *J. Buchanan* (holotype: WELT 59580).

Plants densely to loosely caespitose, shortly rhizomatous. **Culms** 20–60(–90) cm, erect, smooth and glabrous, usually scabrous immediately below the inflorescence, branching extravaginal, cataphylls scaly. **Leaves** mostly basal, exceeded by or as long as the culms, flag leaf blades usually reaching the inflorescences; **sheaths** glabrous or with scattered hairs, with apical tufts of hairs, hairs to 4 mm long; **ligules** 0.2–0.5 mm long; **blades** (5–)15–25(–75) cm long, to 2 mm wide, flat or involute, glabrous or pubescent. **Inflorescences** racemose or with a few branches, 5–15 cm long, lanceolate; **rachis** scabrous; **pedicels** shorter than spikelets, scabrous. **Spikelets** (7–)10–13(–16) mm long, 6–7(–10) florets; **glumes** (7–)8–13(–16) mm long, surpassing florets, subequal, lanceolate, subacute, glabrous or sometimes with a few hairs, light green to stramineous often purple at margins and apex; **lower glumes** (5–)7-veined; **upper glumes** 5(–7)-veined; **rachilla segments** 0.1–0.2 mm long; **calluses** (0.6–)0.9–1.5(–2) mm long, hairs 1.0–1.5 mm long and not or barely reaching the lower lemma hairs; **lemmas** 2.5–3.5(–4.5) mm long, (7–)9 veins, lower row of hairs dense, hairs not or just reaching the upper rows, upper row of hairs reaching or slightly exceeding the base of the awn, scanty medial tufts usually present or sometimes absent, glabrous elsewhere; **lobes** 5–10 mm long, abruptly aristate; **awn** 11–14 mm long, lightly twisted column 2–3 mm long, somewhat reflexed at the base and revealing palea apex; **paleas** 3.5–5 mm long, exceeding the lemma sinuses, emarginate, glabrous or with a few hairs, veins ciliate; **anthers** 0.3–2 mm long. **Caryopses** 1.7–2.1(–2.5) mm × 0.8–1.1(–1.3) mm; **embryos** 0.8–0.9 mm long; **hila** 0.4–0.5 mm long. $2n = 24$; Australian plants (Abele 1959; Brock & Brown 1961) and Californian plants (this paper).

This highly variable species is endemic to southern Australia where it "displays a bewildering variety of forms" (Vickery 1956). Connor and Edgar (1979) described the upper hairs on the lemma as rarely forming a continuous row of tufts, but this state has not been observed in any material from North America. An extreme form with short abruptly acute or mucronate lemma lobes is often recognized as *R. racemosum* var. *obtusatum* (Benth.) Connor & Edgar, but all material from the United States is typical var. *racemosum*.

Naturalized primarily as a ruderal weed in disturbed areas less than 200 m in elevation. It is a common weed of lawns and roadsides around Berkeley, California (Blumler 2001; Ertter, personal observation), and has also been collected at Davis (Fig. 4D). St. John (1973) stated that it was introduced to Hawai'i in 1937, but we were unable to locate specimens to confirm this.

Introduced and grown for forage trials at several locations in North America, this species is frequently confused with *R. penicillatum*. Although the earliest North America record located dates from cultivation at Berkeley in 1941, it was probably grown in earlier times under the name of *Danthonia pilosa*. It was present in New Zealand as early as 1840 (Zotov 1963). In the United Kingdom, var. *obtusatum* has been reported as introduced with wool-waste (Lousley 1961; Ryves 1988), but has not become fully naturalized (Stace 1997).

Specimens examined: **CALIFORNIA. Alameda Co.:** Berkeley, cultivated in the Agronomy Division grass garden, Row 15, plot 12, 1941, *A.A. Beetle s.n.* (AHUC, DAO); Berkeley, at corner of Hearst and Oxford, May 1951, *A. Haig s.n.* (AHUC, DAV); Berkeley, Campus of Univ. of California, Life Sciences Bldg., growing under *Eucalyptus* trees, 11 Sep 1952, *R.W. Pohl 7201* (UC); Berkeley, UC Campus, along Hearst Ave sidewalk, Oxford Tract, volunteer, 25 Aug 1953, *B. Crampton 1609* (AHUC); W side of Albany Hill, along path SE of condominiums, sandstone substrate, in open eucalyptus forest, very localized but common at this one locality, 13 Jun 1998, *B. Ertter 16207* (DAO, UC); north Berkeley, weedy sites in residential area, including as weed in lawns, occasional, 19 Jul 2000, *B. Ertter 17419* [p.p.] (DAO, UC); Mendocino Ave. at Marin Circle in north Berkeley, well-developed population in lawns of several adjacent residential lots, 19 Jun 2003, *B.*

Ertter 18216 (CHR, DAO, UC); 859 Alameda N of Solano Ave. in north Berkeley, local population in lawns of adjacent residential lots, 19 Jun 2003, *B. Ertter 18217* (DAO, UC); Berkeley, 1601 Spruce St. just S of Cedar St., N of UC campus, local population at edge of sidewalk in single residential lot, 19 Jun 2003, *B. Ertter 18218* (CHR, DAO, UC); N of UC campus in Berkeley, 1770 Arch St. N of Hearst Ave., local population in streetside strip of single residential lot, 19 Jun 2003, *B. Ertter 18219* (DAO, UC); 1108 Fresno Ave. S of Monterey Ave. in north Berkeley, local population at edge of lawn and sidewalk of residential lot, 20 Jun 2003, *B. Ertter 18220* (CHR, DAO, UC); Berkeley NW of UC campus, 1766 Walnut St., local population at edge of lawn and sidewalk of residential lot, 20 Jun 2003, B. *Ertter 18221* (CHR, DAO, UC); north Berkeley, 11601 Bonita Ave. at Cedar St., local population at edge of lawn and sidewalk of single residential lot, 20 Jun 2003, *B. Ertter 18222* (CHR, DAO, UC); north Berkeley, NE corner of Hopkins St. and The Alameda, lush plants of population appearing at edges of lawns and sidewalks for several residential blocks, 20 Jun 2003, *B. Ertter 18223* (CHR, DAO, UC); Albany, W side of Albany Adult School on San Gabriel Ave. S of Brighton Ave., abundant and lush plants among neglected shrubbery along sidewalk, 21 Jun 2003, *B. Ertter 18224* (CHR, DAO, UC) [$n = 12$]. **Marin Co:** Angel Island, perimeter road just N of West Garrison, locally common as a roadside weed, 1978, *G.H. True 8468* (AHUC). **Yolo Co.:** Davis, yard of B.A. Madson, 11 Jun 1951, *B.A. Madson s.n.* (AHUC).

Rytidosperma richardsonii (Cashmore) Connor & Edgar, New Zealand J. Bot. 17:332. 1979. (**Fig. 2A**).

Danthonia richardsonii Cashmore, Commonw. Austral. C. S. I. R. Bull. 69: Appendix, 2. 1932. *Notodanthonia richardsonii* (Cashmore) Veldkamp, Taxon 29:297. 1980. *Austrodanthonia richardsonii* (Cashmore) H.P. Linder, Telopea 7:273. 1997. Type: AUSTRALIA. South Australia: Werribee, 2 Dec 1932, *A.B. Cashmore Ga63*. (holotype: AD (fide Vickery op. cit.: 281); isotype: BM, K, NSW).

Plants densely caespitose, without rhizomes. **Culms** 45–80(–100) cm, erect, smooth and glabrous, glabrous or sparsely scabrous immediately below inflorescence; branching intravaginal. **Leaves** mostly basal, exceeded by culms; flag leaf reaching inflorescence or not; **sheaths** glabrous, apical tufts of hairs 1–5 mm long sometimes scant; **ligules** 0.5–1.5 mm long; **blades** 10–50 cm long, 1.5–4 mm wide, flat or involute when dry, glabrous or sometimes adaxially scabrous. **Inflorescences** paniculate, 4–10 cm long, broadly lanceolate to ovate, compact; **rachis** glabrous to sparsely pubescent; **pedicels** shorter than spikelets, scabrous to pubescent. **Spikelets** 10–15 cm long, 4–6 florets; **glumes** 11–13 mm long, surpassing florets, subequal, broadly lanceolate to ovate, acute, glabrous, green to light green or stramineous with age, lacking purple pigments; **lower glumes** 7–11 veins; **upper glumes** 7–9 veins; **rachilla segments** 0.4 mm long; **calluses** 0.5–1 mm long, hairs 1–2.5 mm long, surpassing base of lower lemma hairs; **lemmas** 3–4.5 mm long, 2 continuous rows of hairs, the lower 1.5–4 mm long, surpassing the base of the upper row, the upper row 3.5–5 mm long, surpassing the lemma sinus, but not the apex of the lemma lobes, pubescent between the rows with shorter hairs; **lobes** to 4.5–6 mm long, aristate; **awn** 6.5–9 mm long, indistinct column 0.5–1 mm long with few twists; **paleas** 3.4–4.5 mm long, equaling or surpassing the lemma sinus, ovate, emarginate, pilose between the veins at the base and glabrous or somewhat pilose on the margins, veins ciliate; **anthers** 0.8 mm long. **Caryopses** about 2.5 × 1.5 mm; **embryos** about 1.5 mm long; **hila** about 0.5 mm long. $2n = 48$; Australian plants (Abele 1959; Brock & Brown 1961) and Californian plants (Myers 1947; this paper).

Indigenous to southeastern Australia, *R. richardsonii* is known in an established population only at the University of California, Berkeley, campus. Here a small, but dense population grows in shrubby grassland at the edge of *Eucalyptus* groves, where it occurs with *R. caespitosum*.

Specimens examined: **CALIFORNIA: Alameda Co.:** Berkeley, NW edge of Strawberry Canyon on E edge of main UC campus, NE of main "viewing area" for "Tightwad Hill" overlooking football stadium, below eucalyptus grove, SE-facing grassland at edge of brush, locally well-established colony forming lush stand of perennial bunch-grass, scattered plants with a few flowering stems, 16 Feb 2002, B. *Ertter 17815* [p.p.] (DAO, UC); Berkeley, NW edge of Strawberry Canyon on E edge of main UC campus, NE of main "viewing area" for "Tightwad Hill" overlooking football stadium, E side of eucalyptus grove, ± dominant at this one site, in full sun (where all dried) to partial shade, 26 Jun 2003, *B. Ertter 18231* (CHR, DAO, UC) [$n = 24$].

Incertae sedis.

CALIFORNIA. San Mateo Co.: San Bruno Mountains, Randolph Ravine, uncommon, in *Stipa pulchra* grassland, 17 Mar 1989, *B. Johnson s.n.* (CAS).

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Flahey prepared the line drawings of florets. The floret paintings by Keith R. West were originally prepared for the revision of New Zealand taxa by Connor & Edgar (1979), but were never published, except for that of *R. biannulare* which appeared in Edgar & Connor (2000). Two paintings are now published for the first time, about 30 years later. We thank CHR for permission to reproduce them here. Herbarium curators at AHUC, BISH, CAS, CDA, CHR, DAO, DAV, HSC, JEPS, MO, OSC, RSA, SBBG, UC, UCR, US, and WILLU are thanked for making material available for study.

REFERENCES

Abele, K. 1959. Cytological studies in the genus *Danthonia*. Trans. Roy. Soc. South Australia 82:163–173.

Blumler, M. 2001. Notes and comments. Fremontia 29:36.

Brock, R.D. and J.A.M. Brown. 1961. Cytotaxonomy of Australian *Danthonia*. Austral. J. Bot. 9:62–91.

Chase, A. 1918. Axillary cleistogenes in some American grasses. Amer. J. Bot. 5:254–258.

Clayton, W.D. and S.A. Renvoize. 1986. Genera Graminum. Grasses of the World. Kew Bull. Addit. Ser. 13.

Connor, H.E. and E. Edgar. 1979. *Rytidosperma* Steud. (*Nothodanthonia* Zotov) in New Zealand. New Zealand J. Bot. 17:311–337.

Darbyshire, S.J. and H.E. Connor. 2003. *Rytidosperma*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 15+ vols. Oxford University Press, New York and Oxford. 25:309–312.

Dean, E., F. Hrusa, G. Leppig, A. Sanders, and B. Ertter. 2008. Catalogue of nonnative vascular plants occurring spontaneously in California beyond those addressed in the Jepson manual – Part II. Madroño 55:93–112.

Edgar, E. and H.E. Connor. 2000. Flora of New Zealand, Volume 5, Gramineae. Manaaki Whenua Press, Lincoln, New Zealand.

Hitchcock, A.S. 1951. Manual of the grasses of the United States. 2nd ed. revised by A. Chase. U.S.D.A. Misc. Publ. 200.

Linder, H.P. 1997. Nomenclatural corrections in the *Rytidosperma* complex (Danthonieae, Poaceae). Telopea 7:269–274.

Linder, H.P. (and 10 others). 2010. A generic classification of the Danthonioideae (Poaceae). Ann. Missouri Bot. Gard. 97:306–364.

Linder, H.P. 2005. *Austrodanthonia*. In: K. Mallett, ed. Flora of Australia. Poaceae 3. CSIRO Publishing, Melbourne, Australia. 44B:45–63.

Linder, H.P. and G.A. Verboom. 1996. Generic limits in the *Rytidosperma* (Danthonieae, Poaceae) complex. Telopea 6:597–627.

Lousley, J.E. 1961. A census list of wool aliens found in Britain, 1946–1960. Bot. Soc. Brit. Isles Proc. 4:221–247.

Murphy, A.H. and R.M. Love. 1950. Hairy oatgrass, *Danthonia pilosa* R. Br., as a weedy range grass. Bull. Calif. Dep. Agric. 39:118–124.

Murray, B.G., P.J. de Lange, and A.R. Ferguson. 2005. Nuclear DNA variation, chromosome numbers and polyploidy in the endemic and indigenous grass flora of New Zealand. Ann. Bot. (Oxford) 96:1293–1305.

Myers, W.M. 1947. Cytology and genetics of forage grasses (concluded). Bot. Rev. (Lancaster) 7:369–419.

Pirie, M.D. (and 13 others). 2008. A novel supermatrix approach improves resolution of phylogenetic relationships in a comprehensive sample of danthonioid grasses. Molec. Phylogenet. Evol. 48:1106–1119.

Ryves, T.B. 1988. Supplementary list of wool-alien grasses recorded from Blackmoor, North Hants, 1959–1976. Watsonia 17:73–79.

Sampson, A.W., A. Chase, and D.W. Hedrick. 1951. California grasslands and range forage grasses. Univ. Calif. Agric. Exp. Sta. Bull. 724:1–131.

St. John, H. 1973. List and summary of the flowering plants in the Hawaiian Islands. Mem. Pacific Trop. Bot. Gard. 1:1–519.

Stace, C. 1997. New flora of the British Isles. 2nd ed. Cambridge University Press, Cambridge, United Kingdom.

Stone, C.P., C.W. Smith, and J.T. Tunison (eds.). 1992. Alien plant invasions in native ecosystems of Hawai'i: management and research. University of Hawaii Press, Honolulu, HI.

Vickery, J.W. 1956. A revision of the Australian species of *Danthonia* DC. Contr. New South Wales Natl. Herb. 2:249–325.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. Manual of the flowering plants of Hawai'i. Revised edition. Bishop Mus. Spec. Publ. 97: i–xviii + 1–1919.

Waters, C., B.G. Murray, G. Melville, D. Coates, A. Young, and J. Virgona. 2010. Polyploidy and possible implications for the evolutionary history of some Australian Danthonieae. Autral. J. Bot. 58:23–34.

Whitney, L.D., E.Y. Hosaka, and J.C. Ripperton. 1939. Grasses of the Hawaiian ranges. Hawaii Agric. Exp. Sta. Bull. 82:1–148.

Weintraub, F.C. 1953. Grasses Introduced into the United States. Agricultural Handbook No. 58. Forest Service, U.S. Department of Agriculture, Washington, D.C., U.S.A.

Zotov, V.D. 1963. Synopsis of the grass subfamily Arundinoideae in New Zealand. New Zealand J. Bot. 1: 78–136.

TYPIFICATIONS OF NAMES IN *AGALINIS*, *GERARDIA*, AND *TOMANTHERA* (OROBANCHACEAE)

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ABSTRACT

Seventeen neotypes and six lectotypes are designated for names in *Agalinis* Raf., *Gerardia* L., and *Tomanthera* Raf.

RESUMEN

Diecisiete neotypes y seis lectotypes son designados para nombres en *Agalinis* Raf., *Gerardia* L. y *Tomanthera* Raf.

During work on a taxonomic treatment of *Agalinis* Raf. (nom. cons.) type specimens were not located for names of species and infraspecific taxa of *Agalinis*, *Gerardia* L. (sensu Pennell 1935) and *Tomanthera* Raf. When original material of A. Michaux, F. Pursh, T. Nuttall and C.S. Rafinesque was not found within herbaria likely to contain it, direct inquires were made to herbaria likely to contain type material. Neotypes are designated here for names for which no original material was located. The majority of neotypes were selected from our own collections so that duplicates (isoneotypes) could be deposited in several herbaria. Care was taken to ensure that new types are concordant with current usage of names as we understand them after many collective years of scientific study of *Agalinis*. Each neotype conforms to the original morphological description of the taxon and was collected from the geographical region indicated in the protologue. Descriptions of new species of *Agalinis* in Rafinesque's New Flora of North America are particularly informative and generally unambiguous.

In only one case was it not possible to identify the taxon to which a name applies although conflicting attempts have been made by various authors. The name *Gerardia erecta* Walter ex J.F. Gmel., the basionym of *Agalinis erecta* (Walter ex J.F. Gmel.) Pennell, is recommended for rejection under Art. 56.1 of the International Code of Botanical Nomenclature (McNeill et al. 2006) as outlined in McNeill et al. (2007).

An illustration by Rafinesque was chosen as lectotype for a name published by him. Syntypes annotated by Bentham, and initially selected as types by F.W. Pennell but not cited as lectotypes are designated here in second step lectotypifications. Lectotypes were selected for a name published by A. Gray and a name published by Rafinesque.

Agalinis corymbosa Raf., New Fl. N. Amer. 2:63. 1837. Type: U.S.A. Florida. Santa Rosa Co.: T1S, 28N, S.24, SE4SW4, ca. 100 plants in mesic to wet longleaf pine savanna, 10 Oct 1998, *J.F. Hays 2005* (neotype, designated here: NLU!; isoneotype: FLAS!).

Rafinesque's ample description of plants he knew from "Carolina and Florida" describes well *Agalinis pinetorum* var. *delicatula* Pennell. This a slender stemmed, narrow leaved variant of *A. harperi* Pennell.

Agalinis longifolia Raf., New Fl. N. Amer. 2:62. 1837. Type: U.S.A. Delaware. New Castle Co.: Delaware 9, just S of jct. with Co. Rd. 454, 2.4 km NW of Flemings Landing, roadside ditch bank with *Ambrosia*, *Aster*, *Setaria*, and *Bidens*, 6 Sep 1983, *J.M. Canne 2476* (neotype, designated here: OAC!; isoneotypes: GH!, MO!, NY!, PH!).

We agree with Pennell (1929) that Rafinesque's morphological description of plants he knew from "Near streams New Jersey to Virginia" fits well the mid- Atlantic populations of *A. purpurea* (L.) Pennell.

Agalinis maritima var. **gracilis** Raf., New Fl. N. Amer. 2:62. 1837. Type: U.S.A. Massachusetts. Bristol Co.: Rte. Mass. 88 N, 0.2 mi. E of entrance to Horseneck Beach State Reservation, ca. 0.1 mi. N of the highway, abundant in *Phragmites*, with *Agalinis purpurea*, 30 Aug 1978, *J.M. Canne and K.A. Hruschak 781* (neotype, designated here: OAC!; isoneotypes: GH!, MO!, NY!, PH!).

Agalinis (originally misspelled Agalims) *maritima* (Raf.) Raf. var. *gracilis* was described as "less branched

slender leaves remote," and falls within the interpopulational variation of *A. maritima* var. *maritima* in the northern portion of the species range along the coast of the New England states.

Agalinis maritima var. **pumila** Raf., New Fl. N. Amer. 2:62. 1837. Type: U.S.A. Massachusetts. Barnstable Co.: western end of Cape Cod, along Shore Road, 2.8 mi N of Pocasset, small salt meadow between highway and railroad, 19 Aug 1977, *J.M. Canne and K.A. Hruschak 511* (neotype, designated here: OAC!; isoneotypes: GH!, MO!, NY!).

Rafinesque described *A. maritima* var. *pumila* as "2 or 3 inches high." Plants of this description are *A. maritima* var. *maritima* known from the coastal regions of New England. Rafinesque knew the species only from "on the Sea shores from New England to Chesapeak bay."

Agalinis microphylla Raf., New Fl. N. Amer. 2:65. 1837. Type: U.S.A. Florida. [Duval Co.]: near Jacksonville, moist pine barrens, 1 Oct 1894, *A.H. Curtiss 5272* (neotype, designated here: FSU!; isoneotypes: GA!, GH!, MIN!, PH!).

We agreed with Pennell (1920, 1929, 1935) who placed *A. microphylla* Raf. in synonymy with *A. aphylla* Nutt. Rafinesque's description of a Leconte collection from Florida in the Collins herbarium is attributable only to *A. aphylla* because he noted the deeply grooved and ribbed stem, the very small, adpressed leaves, "spicate" inflorescence, short calyx lobes, and the few, alternate, virgate branches. The collection by Curtiss from Duval Co., Florida is from an area in which Leconte is known to have worked (Gray 1883).

Agalinis obtusifolia Raf. New Fl. N. Amer. 2:64. 1837. Type: U.S.A. Florida. Santa Rosa Co.: along Florida 4, 0.7 km W of the Okaloosa Co. line, E of Munson, longleaf pine, wiregrass savanna, 25 Sep 1999, *J.M. Canne-Hilliker 3427 with John F. Hays* (neotype, designated here: OAC!; isoneotypes: GH!, MO!, NY!, PH!).

Rafinesque's mention of angular, filiform stems; sulcate, obtuse, callose (silicified), leaves; peduncles much longer than leaves; minute, callose calyx teeth; and short broad corollas clearly denote the species as treated by Pennell (1929, 1935). Rafinesque noted the species occurred in "West Tennessee, Alabama and Florida."

Agalinis palustris var. **corymbosa** Raf. New Fl. N. Amer. 2:62. 1837. Type: U.S.A. New Jersey. Camden Co.: Atco, at jct. Jackson Rd. and Ashland Ave., moist, swampy area at margin of *Pinus* woods with *Bidens* and *Ambrosia*, 8 Sep 1983, *J.M. Canne 2521* (neotype, designated here: OAC!; isoneotypes: GH!, MO!, NY!, PH!).

Rafinesque published *Agalinis palustris* as a new name for *Gerardia purpurea* L. (= *Agalinis purpurea* (L.) Pennell) (typ. cons.). Although *A. palustris* Raf. is an illegitimate name, in accordance with Art. 55.2 of the International Code of Botanical Nomenclature (McNeill et al. 2006) the varietal names published by Rafinesque under *A. palustris* are legitimate. *Agalinis palustris* var. *corymbosa* was described as "branches crowded corymbose." Rafinesque provided no information about the distribution of his varieties of *A. palustris* but noted that the species occurred "From New England to Carolina." He did not mention specimens seen in herbaria.

Agalinis palustris var. **divaricata** Raf. New Fl. N. Amer. 2:62. 1837. Type: U.S.A. South Carolina. Colleton Co.: U.S. 21, approx. 0.3 km S of Ruffin, 2.7 km N of the jct. with S.C. 64, weedy margin of *Pinus* woodland with *Solidago, Chrysopsis, Cyperus, Aster, Liquidambar, Mikania*, 7 Oct 1981, *J.M. Canne 2217* (neotype, designated here: OAC!; isoneotypes: GH!, MO!, NY!, PH!).

Rafinesque described *A. palustris* var. *divaricata* as "less branched slender leaves remote." Both of Rafinesque's varieties of *A. palustris* fall within the interpopulational variation found in the widespread *A. purpurea* var. *purpurea*.

Agalinis setacea var. **humilis** Raf. New Fl. N. Amer. 2:64. 1837. Type: U.S.A. New Jersey. Atlantic Co.: jct. Co. Rd. 563 and Oken St. on NE side of Egg Harbor, sandy, weedy, grassy flat at edge of *Quercus, Pinus* woods with *Heterotheca, Eupatorium, Solidago, Lespedeza*, 7 Sep 1983, *J.M. Canne 2512* (neotype, designated here: OAC!; isoneotypes: GH!, MO!).

Rafinesque listed the range of *Agalinis setacea* as from "New Jersey to Alabama and Kentucky, Illinois" and described his varieties based on height; *A. setacea* var. *humilis* was said to be "6 to 10 inches."

Agalinis setacea var. **major** Raf. New Fl. N. Amer. 2:64. 1837. Type: U.S.A. South Carolina. Georgetown Co.: along state road 261, 7.6 km W of the jct. with US 701 in Yauhannah, and 6.8 km E of jct. with SC 513, occasional in white sand in a *Pinus, Quercus* flatwoods, 1 Oct 2000, *J.M. Canne-Hilliker 3519* (neotype, designated here: OAC!; ISONEOTYPE: MO!).

Agalinis setacea var. *major* was described as "1 or 2 feet more branched." Plant height and degree of branching

are of little taxonomic significance because both characters vary within populations. Also, as in other species of *Agalinis*, plants of *A. setacea* in more southern locations generally grow taller and have more branches than those in the northern extremes of the species range.

Agalinis tenuifolia var. **humilis** Raf. New Fl. N. Amer. 2:64. 1837. TYPE: U.S.A. MISSOURI. Franklin Co.: E of Oak Hill at the jct. of Parshall Road and Little Boubeuse Road, locally common on weedy embankment under *Quercus* with *Trifolium*, *Solidago* and asters, 26 Sep 2004, *J.M. Canne-Hilliker 3602* (NEOTYPE, designated here: OAC!; ISONEOTYPES: GH!, MO!, NY!, PH!).

Rafinesque described *A. tenuifolia* var. *humilis* as "semipetal few branches," a minor distinction of no taxonomic value for plants of this very widespread and variable species. Although Rafinesque listed the range of the species "from Canada to Florida and Missouri" he did not publish locality data for his new varieties.

Agalinis tenuifolia var. **saxatilis** Raf. New Fl. N. Amer. 2:64. 1837. TYPE: U.S.A. TENNESSEE. Polk Co.: along US 64 on N side of the Ocoee River, 7.4 km W of Gassoway Creek, steep rock embankment with *Aureolaria*, *Hamamelis*, *Quercus*, *Pinus* and *Liquidambar*, 22 Sep 1999, *J.M. Canne-Hilliker 3409* (NEOTYPE, designated here: OAC!; ISONEOTYPES: GH!, MO!, NY!).

Rafinesque described this variety as "leaves longer, branches divaricate." This also is an inadequate basis for differentiation of infraspecific taxa in this widespread species.

Agalinis virgata Raf. New Fl. N. Amer. 2:62–63. 1837. TYPE: U.S.A. NEW JERSEY. Camden Co.: Parkdale, moist sphagnous depressions, 13 Sep 1911, *F.W. Pennell 3584* (NEOTYPE, designated here: PH!; ISONEOTYPE: PENN!).

Pennell (1929) was unable to locate a type for *Agalinis virgata* Raf., but nonetheless used the name for a taxon we consider to be a taxonomically insignificant variant of *A. purpurea* (L.) Pennell. Rafinesque described plants from "glades of Pine woods in South New Jersey near Mullica Hill."

Gerardia leucanthera Raf. Florula ludov. 50. 1817. TYPE: U.S.A. LOUISIANA. Caddo Parish: along LA 789 S of Spring Ridge and N of Keatchie, 1.4 km SW of the jct. of LA 789 and Preston Road (PR102), locally common at margin of *Quercus*, *Pinus* woodland, 1 Oct 2004, *J.M. Canne-Hilliker 3616* (NEOTYPE, designated here: OAC!; ISONEOTYPES: MO! NY!).

Rafinesque's description clearly refers to a variant of *Agalinis tenuifolia* (Raf.) Raf. in which the style is held above the densely white lanose abaxial anthers. The plants were described as three feet tall, but plant height is variable within and among populations. The description by Robin (1807) upon which Rafinesque based his account of *G. leucanthera* is an excellent depiction of *A. tenuifolia*.

Gerardia maritima Raf. Med. Repos. II. 5:361. 1808. TYPE: Plate No. 8, A Collection of 29 plates and 46 figures of new genera and species of plants from North America by C.S. Rafinesque, Mertz Library of the New York Botanical Garden (LECTOTYPE, designated here: NY, digital image!).

We and Pennell (1929, 1935) were unable to locate original Rafinesque specimens referable to *G. maritima* in North American and European herbaria. However, the plate of *Gerardia maritima* by Rafinesque at NY is an identifiable portrayal of the taxon. Pennell (1929) stated that "An unpublished plate of Rafinesque's in the library of the New York Botanical Garden denotes clearly the plant here considered." Merrill (1949) noted that the plates at NY are likely the only remaining evidence that illustrate Rafinesque's American species prior to the loss of Rafinesque's herbarium in a shipwreck off Long Island in 1815. Gerard (1885) quoted the notation made by Rafinesque on the first plate of the set in which Rafinesque explained that the plates were proofs of plates lost in the shipwreck of 1815, and are figures of plants for which names were published in 1807, 1808 and 1814. Rafinesque's plate of *Gerardia maritima* shows a complete plant and nine numbered insets which include in numerical order: a leaf; flower; calyx and style; calyx opened showing the ovary with style; longitudinal section of a corolla; capsule with calyx; lateral view of an open capsule; cross section of a capsule; and seeds. The habit sketch shows an elongate main stem with shorter basal branches, and flowers with blunt calyx lobes that are distinctive of *Agalinis maritima* (Raf.) Raf. in the northern part of its range.

Tomanthera lanceolata Raf., New Fl. N. Amer. 2:66. 1837. TYPE: *Erinus*, *Gerardia auriculata*, Muhlenberg Herbarium 851 (LECTOTYPE, designated here: PH, digital image!).

Rafinesque (1837) cited " Erinus! africanus Muhl." with his description of *T. lanceolata*. Earlier, Nuttall (1818)

stated in reference to *Gerardia auriculata* Michaux (= *Tomanthera auriculata* (Michx.) Raf.) that: "This plant is considered to be *Erinus Africanus* in Muhlenberg's Catalogue, but surely neither the same species nor genus, if there be any essential character in *Erinus*." While living in Philadelphia Rafinesque evidently saw the Muhlenberg specimen because he equated it with his new *T. lanceolata*. *Erinus africanus* is a Linnaean name, so we interpret Rafinesque's citation of " Muhl." to be equivalent to "sensu Muhl., non L." Rafinesque gave the distribution of *T. lanceolata* as: "In Pensylv. and Carolina, my specimen of Collins herb. was collected by Dr. Cleaver in New Jersey..." The reference to Pennsylvania presumably referred to the specimen in Muhlenberg's herbarium. After Muhlenberg's death in 1815 his herbarium went to the American Philosophical Society at The Academy of Natural Sciences of Philadelphia in 1818 (Merrill and Hu 1949). Rafinesque's' description is applicable to *Agalinis auriculata* (Michx.) S. F. Blake. The lectotype specimen has the distal segments of two flowering branches or two small plants of *Agalinis auriculata*.

Gerardia filifolia Nutt., Gen. N. Amer. pl. 2:48. 1818. Type: U.S.A. Florida. Bay Co.: Bay Co. Rd. 388, 4.4 km E of the jct. with Florida 79, just N of West Bay, occasional in white sand with lichen, palm, *Carphephorus*, *Quercus*, and *Sabatia*, 30 Sep 1999, *J.M.Canne-Hilliker 3491* (neotype, designated here: OAC!; isoneotypes: MO!, NY!).

Nuttall's description is absolutely distinctive of *Agalinis filifolia* (Nutt.) Raf., the only species of *Agalinis* with "filiform, carnose, subfasciculate, and alternate" leaves.

Gerardia purpurea L. var. **crassifolia** Pursh, Fl. Amer. sept. 2:422. 1814. Type: U.S.A. New York. Nassau Co.: Merrick, salt marsh, 3 Oct 1916, *F.W. Pennell 9359* (neotype, designated here: PH!).

Pursh's description is that of *Agalinis maritima* (Raf.) Raf. var. *maritima* from salt marshes near New York.

Gerardia aspera Benth., in DC. Prodr. 10:517–518. 1846. Type: plains of the Red River, 1827, *Douglas s.n.* (lectotype [second step], designated here by J.M. Canne-Hilliker: K!; isolectotype: K!).

Bentham listed three collections he had seen. From these Pennell (1935) cited the Douglas collection from Bentham's herbarium as "the actual type," a first step lectotypification, although Pennell did not annotate the type he saw at Kew.

Gerardia purpurea L. var. **parviflora** Benth., Companion Bot. Mag. 1:208. 1836. Type: Norway House to Canada, *Drummond s.n.* (neotype, designated here by J.M. Canne-Hilliker: K!).

Bentham cited a specimen from Boston for his new variety, but this specimen has not been found. The Drummond specimen from Bentham's herbarium at Kew bears his pencil notation "α" for the first of the two varieties he described for *G. purpurea*. However, it cannot be determined definitively that Bentham saw this Drummond specimen prior to publication of the new varietal name. Thus the Drummond specimen is designated as a neotype. Norway House was a trading post on Playgreen Lake, north of Lake Winnipeg, Manitoba, Canada visited by Drummond on the Second Land Arctic Expedition during 1825–1827 (Bird 1967).

Gerardia purpurea L. var. **paupercula** A. Gray, Syn. fl. N. Amer. 2:293. 1878. Type: U.S.A. Pennsylvania. Erie Co.: Presque Isle, 25 Oct 1864, *G.W. Clinton s.n.* (lectotype, designated here by J. M. Canne-Hilliker: GH!; isolectotype: PH!).

Gray did not cite a specimen, but made the comment that a Porter name, "in herb.," should be used if the taxon was treated as a distinct species. A specimen at GH bears a hand written letter from Thomas C. Porter in which the morphology of Gray's variety is described. Porter described a collection of fruiting plants by G. W. Clinton, Oct 1864 and two collections of flowering plants made by A. P. Garber in July 1868 and 1869 at Presque Isle. The three fruiting plants of G. W. Clinton on the right hand side of the specimen, mounted directly above the lectotype label, are the lectotype at GH. This taxon is treated by us as *Agalinis purpurea* (L.) Pennell var. *parviflora* (Benth.) Boivin.

Gerardia tenuifolia Vahl var. **leptophylla** Benth. Companion Bot. Mag. 1:209. 1836. Type: LOUISIANA: *Drummond s.n.* (lectotype [second step] designated here by J.M. Canne-Hilliker: K!).

Pennell (1920) said the type of *Gerardia tenuifolia* var. *leptophylla* was a Drummond collection from "Jack-

sonville, Louisiana" (first step typification). However, in his protologue Bentham listed two collections, "Jacksonville and Louisiana, Drummond," for his new taxon. There is a specimen at Kew attributed to Drummond from Louisiana upon which Bentham wrote "*G. tenuifolia leptophylla*." This specimen, the lectotype, is a plant of *Agalinis gattingeri* (Small) Small and is annotated with this name by Pennell.

Gerardia tenuifolia Vahl var. **macrophylla** Benth., Companion Bot. Mag. 1:209. 1836. TYPE: St. Louis, *Drummond s.n.* (LECTOTYPE [second step] designated here by J.M. Canne- Hilliker: K!).

Bentham cited "Jacksonville and St. Louis, Drummond" for specimens of *G. tenuifolia* var. *macrophylla*. Pennell (1920) reported that he had seen a "Fragment of type, from Kew Herbarium, labeled St. Louis." From the two syntypes he thus selected the St. Louis specimen, via the fragment, as the lectotype (first step lectotypification).

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REFERENCES

BIRD, C.D. 1967. The mosses collected by Thomas Drummond in Western Canada, 1825–1827. Bryologist 70:262–266.

GRAY, A. 1883. Some North American botanists. IV. John Eatton LeConte. Bot. Gaz. (Crawfordsville) 8:197–199.

GERARD, W.R. 1885. Reliquiae Rafinesquianae. Bull. Torrey Bot. Club 12:37–38.

MCNEILL, J., F.R. BARRIE, H.M. BURDET, V. DEMOULIN, D.L. HAWKSWORTH, K. MARHOLD, D.H. NICOLSON, J. PRADO, P.C. SILVA, J.E. SKOG, J.H. WIERSEMA, AND N.J. TURLAND (EDS.). 2006. International code of botanical nomenclature (Vienna Code) adopted by the Seventeenth International Botanical Congress Vienna, Austria, July 2005. Regnum Veg. 146.

MCNEILL, J., S.A. REDHEAD, AND J.H. WIERSIMA. 2007. Guidelines for proposals to conserve or reject names. Taxon 56:249–252.

MERRILL, E.D. 1949. Index Rafinesquianus. Arnold Arboretum, Jamaica Plain, Massachusetts.

MERRILL, E.D. AND S-Y. HU. 1949. Work and publications of Henry Muhlenberg, with special attention to unrecorded or incorrectly recorded binomials. Bartonia 25:1–66.

NUTTALL, T. 1818. The genera of North American plants, 2. Facsimile of the 1818 edition, Hafner Publ. Company, New York. 1971.

PENNELL, F.W. 1920. Scrophulariaceae of the southeastern United States. Proc. Acad. Nat. Sci. Philadelphia 71:224–291.

PENNELL, F.W. 1929. *Agalinis* and allies in North America. II. Proc. Acad. Nat. Sci. Philadelphia 81:111–249.

PENNELL, F.W. 1935. The Scrophulariaceae of eastern temperate North America. Monogr Proc. Acad. Nat. Sci. Philadelphia 1:1–650.

ROBIN, C.C. 1807. Voyages dans l'interieur de la Louisiane 3:313–551. Paris.

BOOK REVIEW

Joseph Ewan and Nesta Dunn Ewan. 2007. **Benjamin Smith Barton, Naturalist and Physician in Jeffersonian America.** (ISBN 978-1-930-72335-1, hbk.). Missouri Botanical Garden Press, P.O. Box 299, St. Louis, Missouri 63166-0299, U.S.A. (**Orders:** www.mbgpress.org). $39.99, xxvi + 1127 pp., 95 b&w illustrations, 7¼" × 10¼".

"...Ages and generations must, sometimes, pass away before a Science can rear its head into system:—even the life of man is, not unfrequently, too limited for the discovery of one solitary, important fact. So immense;—so infinite, is Nature, so little is man..."

So wrote young Benjamin Smith Barton (1766–1815), a dedicated physician, lecturer, and teacher who helped further medical science in the New World. However, as the above quote suggests, his first love was that of the natural sciences, and his devotion to that science makes him instrumental in the development of American natural history and best known as the first professional naturalist in the newly formed United States of America.

Sadly, dying in his forties, he fell short of reaching all that he wished to accomplish. Even so, the list of his accomplishments is extensive. He authored the first textbook on botany written in the United States, *Elements of Botany*, as well as numerous other publications, including *Collections for an Essay Towards a Materia Medica of the United States*, and *New Views of the Origin of the Tribes and Nations of America*. From 1804–1809, he served as editor of the *Philadelphia Medical and Physical Journal*, one of the oldest scientific publications of the United States. He instructed Meriwether Lewis in plant identification and collection to assist with the gathering of plant specimens during Lewis and Clark's Corps of Discovery expedition (1804–1806).

Underpinned throughout the early botanical history of America can be found the influence of Benjamin Smith Barton: he preserved many of the observations of American botanists, like those of William Bartram, whose best-selling *Travels* (1791) strongly influenced English Romanticism; on Barton's western trip in 1785, researching his incomplete Flora of North America, Barton (out of his own pocket) supported the assistance of two botanists, Fredrick Pursh and Thomas Nuttal, who would go on to attain greater fame in the field than Barton. Notables such as Baldwin, Darlington, Ives, Horsfield, and John Richardson Young, for example, attest to his inspiration. "He was a veritable squirrel in the woods of natural history, collecting, planting, leaving nuts for others to carry off," say authors Joseph and Nesta Ewan.

Barton's wide-ranging interests brought forth vast amounts of correspondence with contemporaries including Thomas Jefferson, Alexander von Humboldt, and Thomas Pennant. These correspondences with Barton provide pivotal insights into the development of early natural sciences in the United States.

Authors Joseph Ewan (1909–1999) and his wife, Nesta Dunn Ewan (1908–2000), were considered two of the leading historians of American botany, and their decades of research into this book is a masterpiece. Laced with interesting insights and interweaving links, this book will open a wealth of archival resources to the researcher.

The authors (at the end of their introduction) leave us with this quote by G.M. Trevelyan: "The poetry of history does not consist of imagination roaming at large, but of imagination pursuing the fact and fastening upon it. ...The dead were and are not. Their place knows them no more and is ours today. Yet they were once as real as we, and we shall tomorrow be shadows like them."—*Linny Heagy, Linny/Designer, Illustrator, email: a0005835@airmail.net*

A NEW COMBINATION IN *LOLIUM PERENNE* (POACEAE: POEAE); *L. PERENNE* SUBSP. *STOLONIFERUM*

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ABSTRACT

A new combination is made in *Lolium perenne*: **L. perenne** subsp. **stoloniferum.**

RESUMEN

Se hace una nueva combinación *Lolium perenne*: **L. perenne** subsp. **stoloniferum.**

Lawson (1836) described a very distinct taxon of the *Lolium perenne* complex as *Lolium perenne* var. *stoloniferum*, giving it the common name of 'Spreading Ryegrass.' Lawson described this new taxon as follows:

"It is of early spring growth, pushing out long prostrate stolons or shoots, with an abundance of foliage, so that one plant, by the time the spikes begin to appear, will form a close tuft, extending from two to three feet in diameter; these shoots, however, although lying on the ground never attempted to strike root until near the end of the season, and even then very sparingly. … [B]ut the length from root [crown] to the point of the spike is often nearly three feet. …"

The very long determinate-stolons, which root at the nodes, and aggressive spreading habit of *L. stoloniferum* are very distinct from *L. perenne* sensu stricto and warrants recognition at the subspecific level, thus necessitating the following new combination.

Lolium perenne L. subsp. **stoloniferum** (C. Lawson) Wipff, comb. et stat. nov. Basionym: *Lolium perenne* L. var. *stoloniferum* C. Lawson, Agric. Man. 104. 1836. Type: OREGON. Linn Co.: S of Hwy 226 and Tennessee Rd. intersection; between Albany and Lebanon, on the West Coast Research Center farm, Barenbrug USA, Inc. 22 Jun 2010, *J.K. Wipff, III 10284* (neotype: US, designated here; isoneotypes: BRCH, BRIT, L, MO, NY).

No collection of specimens cited within the protologue and no record of collections deposited in a herbarium could be found, so a neotype is designated here.

Discussion regarding the basionym:

At first it appears that Lawson (1836) was describing a new species because his protologue (pg. 104) started as follows: "10. Spreading Ryegrass (*L. stoloniferum*)."

But an examination of his treatment reveals several places where his intention that he recognized this taxon at the varietal rank, and not at a specific rank. Indicating he was actually describing a new variety of *L. perenne* and not a new species of *Lolium*. Lawson (1836) explicitly recognized this new taxon at the rank of a variety on the following pages.

1. Pg. 102. …"Like other plants which have received an extensive cultivation, there are several varieties of the Common Ryegrass, the principal of which are as follows:— …"
   He then goes on to describe 11 varieties of *L. perenne*, one which (no. 10) being Spreading Ryegrass.
2. Pg. 104. "10. Spreading Ryegrass (*L. stoloniferum*).—This name is applied to a remarkably stoloniferous variety, the seeds of which were procured from Germany, …"
3. Pg. 105. "The above are the most esteemed varieties of *Lolium perenne*, but there are many more of inferior importance, and possessing less permanent characters."

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REFERENCES

Lawson, C. 1836. Agriculturist's manual: agricultural plants cultivated in Europe; climate of Great Britain. Forming a report of Lawson's Agricultural Museum in Edinburgh. William Blackwood and Sons, Edinburgh, Scotland.

PALEOCHARIS NEARCTICA GEN. AND SP. NOV (CYPERACEAE) IN CRETACEOUS CANADIAN AMBER

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ABSTRACT

Paleocharis nearctica gen. & sp. nov. (Cyperaceae) is described from a Late Cretaceous achene preserved in Canadian amber. *Paleocharis* is characterized by a narrowly oblong, slightly falcate lenticular achene with a cuneate base and truncate apex, a weak constriction between the lanceolate - obclavate stylopodium that is only slightly set off from the achene, and numerous (over 200) smooth hair-like perianth bristles. The proximal half of each bristle is composed of thick-walled dark cells while the distal half is formed by thin-walled, light-colored cells.

KEY WORDS: Cretaceous amber, fossil sedge, Cyperaceae, Alberta, Canada

RESUMEN

Se describe **Paleocharis nearctica** gen. & sp. nov. (Cyperaceae) a partir de un aquenio del Cretácico superior conservado en ámbar de Canadá. *Paleocharis* se caracteriza por un aquenio estrechamente oblongo, ligeramente falcado y lenticular con una base cuneada y ápice truncado, una débil constricción entre el estilopodio lanceolado - obclavado que apenas sobresale del aquenio, y las cerdas del perianto (más de 200) semejantes a pelos lisos. La mitad proximal de cada cerda se compone de células oscuras de paredes gruesas mientras que la mitad distal está formada por células claras de paredes finas.

INTRODUCTION

Extant Cyperaceae are well represented in temperate, sub-arctic, and especially tropical regions worldwide from sea-level to over 5000 m, with genera concentrated in northern South America, southern Sudano-Zambesian Africa, and SW Australia (Goetghebeur 1998). Endemism in the family, at the generic level, is also concentrated in tropical America, tropical South Africa, and Australia (Goetghebeur 1998).

Cyperaceae are thought to have evolved during the Tertiary Period, with fossil records traced to the Paleocene (Raven & Axelrod 1974; Daghlian 1981; Smith et al. 2009), and are hypothesized have a West Gondwana origination (Bremer 2002). Here we describe a new fossil cyperaceous taxon preserved in Cretaceous Canadian amber. The amber piece containing the fossil originated from deposits of subbituminous coals and associated shales in Grassy Lake, Alberta, Canada. The amber-bearing sediments belong to the Late Cretaceous (Campanian) Foremost Formation (Judith River Group). These deposits were originally dated by Eberth and Hamilton (1993) at 79 million years and more recently by McKellar et al., (2008) at between 79.0 and 78.2 Ma.

MATERIALS AND METHODS

The single specimen, which is essentially complete, was embedded in bioplastic for stabilization and mounted on a microscope slide (Fig. 1). While embedding specimens in bioplastic may stabilize the amber, it often restricts observations. Since the bioplastic covers all edges of the slide, the specimen could not be observed from the sides. Also, a milky deposit restricted examination of the opposite side of the specimen. Nevertheless, a clear unobstructed view of the dorsal surface of the specimen showed the important taxonomic characters. Observations and photographs were made with a Nikon stereoscopic microscope SMZ-10R and Nikon Optiphot microscope TM at magnifications up to 600×.

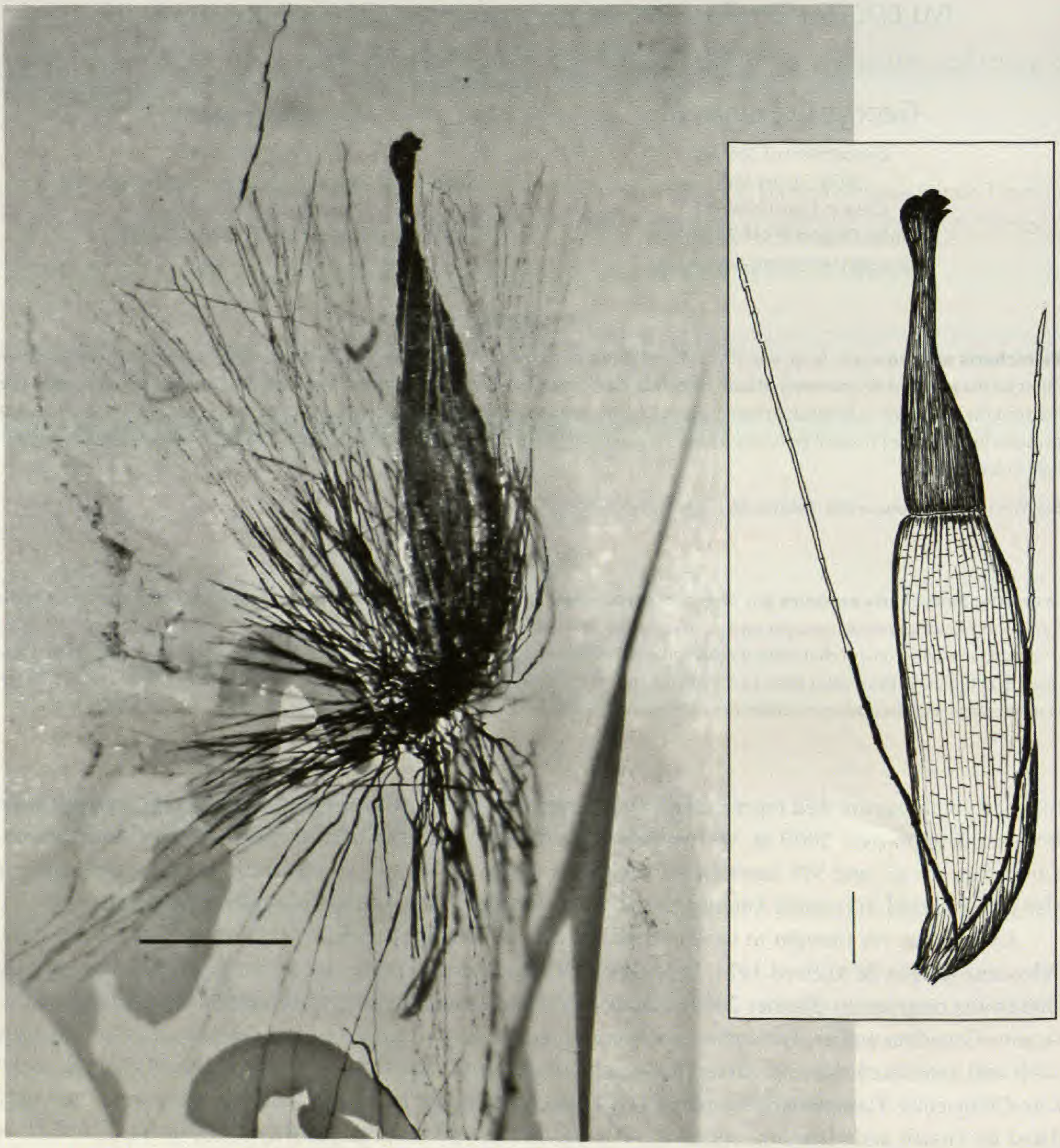

Fig. 1. Holotype of *Paleocharis nearctica* gen. and sp. nov. in Cretaceous Canadian amber. Scale bar = 770 µm. Fig. 2 (inset). Drawing of *Paleocharis nearctica* gen. and sp. nov. in Cretaceous Canadian amber. Only two of the bristles are shown. Scale bar = 250 µm.

DESCRIPTION

The fossil is represented by a mature achene with an attached stylopodium (tubercle) and numerous hair-like perianth bristles. The specimen is complete, with only some of the bristles detached. Some minor compression and distortion occurred during the fossilization process.

Paleocharis Poinar & D.J. Rosen, gen. nov. Type: *Paleocharis nearctica* Poinar & D.J. Rosen, sp. nov.

***Generic diagnosis*: Achenes** with persistent style base (stylopodium), and numerous (over 200) smooth hair-like bristles equaling the length of the achene plus the stylopodium. The proximal half of each bristle is composed of thick-walled dark cells while the distal half is formed by thin-walled, light-colored cells.

Paleocharis nearctica Poinar & D.J. Rosen, sp. nov. (**Figs. 1–4**). TYPE: CANADA. ALBERTA: Grassy Lake amber deposits of subbituminous coals and associated shales, Foremost Formation, Late Cretaceous (middle Campanian), no date, *Ted Pike s.n.* (HOLOTYPE: Royal Tyrrell Museum in Drumheller, Alberta, Canada, accession number PMA 78.15).

Specific diagnosis: **Flowers** with numerous (over 200) smooth, hair-like perianth bristles, 2.6–3.0 mm long, equaling the length of the achene plus the stylopodium (Figs. 1, 2); each bristle composed of a single row of 14–20 elongate cells; cells 0.1–0.26 mm long × 0.1–0.16 mm wide; proximal half of each bristle composed of thick-walled dark cells while distal half formed by thin-walled, light-colored cells (Fig. 3); stamens not seen; style with short lobes. **Achenes** narrowly oblong, lenticular, 1.7 mm long × 0.48 mm wide; surface with transversely oblong cells, smooth except for some delicate microscopic scales ranging from 0.58–0.7 mm in length (Fig. 4); dark brown; base cuneate, apex truncate with weak constriction (Fig. 2); **Stylopodium** lanceolate-obclavate, 1.2 mm long × 0.28 mm wide, dark brown (Fig. 2).

Etymology.—"Paleo" is from the Greek "palaios" for ancient and "charis" is Greek for beautiful. "nearctica" refers to the geographic location of the fossil.

DISCUSSION

Consideration was given to the possibility that the achene could belong to other plant taxa. Members of the Asteraceae also have achenes as fruits, and a persistent calyx (pappus) comprising numerous capillary bristles in many species (Zomlefer 1994; Simpson 2006). However, the bristles are positioned apically usually crowning the achene rather than basally as in Cyperaceae (Zomlefer1994; Simpson 2006). Members of *Salix* L. and *Populus* L. of the Salicaceae have seeds with long, silky hairs, however these seeds do not contain tubercles or have pointed tips and the hairs on the seeds are flexible and single-celled, not stiff and multicelled. In addition some of the hairs on *Salix* and *Populus* seeds arise from the seed coat, whereas in the fossil, all of the bristles are hypogenous (Woody-Plant seed Manual 1948).

Paleocharis shows morphological resemblance to extant species in *Eleocharis* R. Br. and *Rhynchospora* Vahl in its achene bearing a swollen and persistent stylopodium, and to *Eriophorum* L. and *Scirpus* L. in its numerous elongate, smooth perianth bristles (Flora of North America Editorial Committee 2002). However, the narrow, elongate achene and stylopodium and numerous smooth, stiff, bi-colored bristles comprised of a single row of cells in *Paleocharis* are unique characters not known to occur in extant sedges. A comparison of the qualitative characters of the fossil fruit with those of the extant genera mentioned above is shown in Table 1. As *Paleocharis* overlaps in more achene morphological characters and dimensions with *Eleocharis* and *Rhynchospora*, we suggest its placement as an extinct member of Cyperoideae Suess (Simpson et al. 2007).

The darker, heavier cells forming the basal portion of the bristles may have insured that the achenes landed with the base making initial contact with the substrate and provided for the absorption of heat to bring about germination as suggested by Lye (2000) for some temperate species of Cyperaceae. The presence of numerous smooth perianth bristles suggests that *P. nearctica* achenes were wind-dispersed, similar to those of *Eriophorum*. In contrast, *Eleocharis* and *Rhynchospora*, both of which a predominance of species with variously barbed bristles, are known to be dispersed by animals, especially birds (Sauer 1988). While most dispersal is external on feathers, there are records of some *Eleocharis* seeds carried in the digestive system of birds (Sauer 1988).

Fossil sedge fruits are fairly common in Tertiary deposits (Collinson et al. 1993; Smith et al. 2009) but there are no accepted Mesozoic fossils. Putative Cyperaceae pollen was reported from Cretaceous deposits in New Zealand (Couper 1953), Berry (1911) described *Carex clarkii* as a putative leaf fossil from Late Cretaceous Coniacian deposits in New Jersey and *Caricopsis laxa* Samylina was described as a putative leaf fossil from the Early Cretaceous of Siberia (Samylina 1960). While Collinson et al. (1993) cite *C. laxa* as the earliest sedge fossil, they comment, "We know of no well-substantiated leaf fossils of the family" and others have regarded *C. laxa* as not being Cyperaceae (Daghlian 1981; Friis et al. 1987). Pollen from the Lattest Santonian to Maastrichtian strata in Western Canada described as *Penetetrapites inconspicuus* Sweet, was later considered as possibly belonging to the Cyperaceae (Sweet 1986; Braman & Koppelhuis 2005) but this has not been confirmed. More recently, Goetghebeur (1998) and Smith et al. (2009) reported that fossils of Cyperaceae are only known with certainty from the Paleocene.

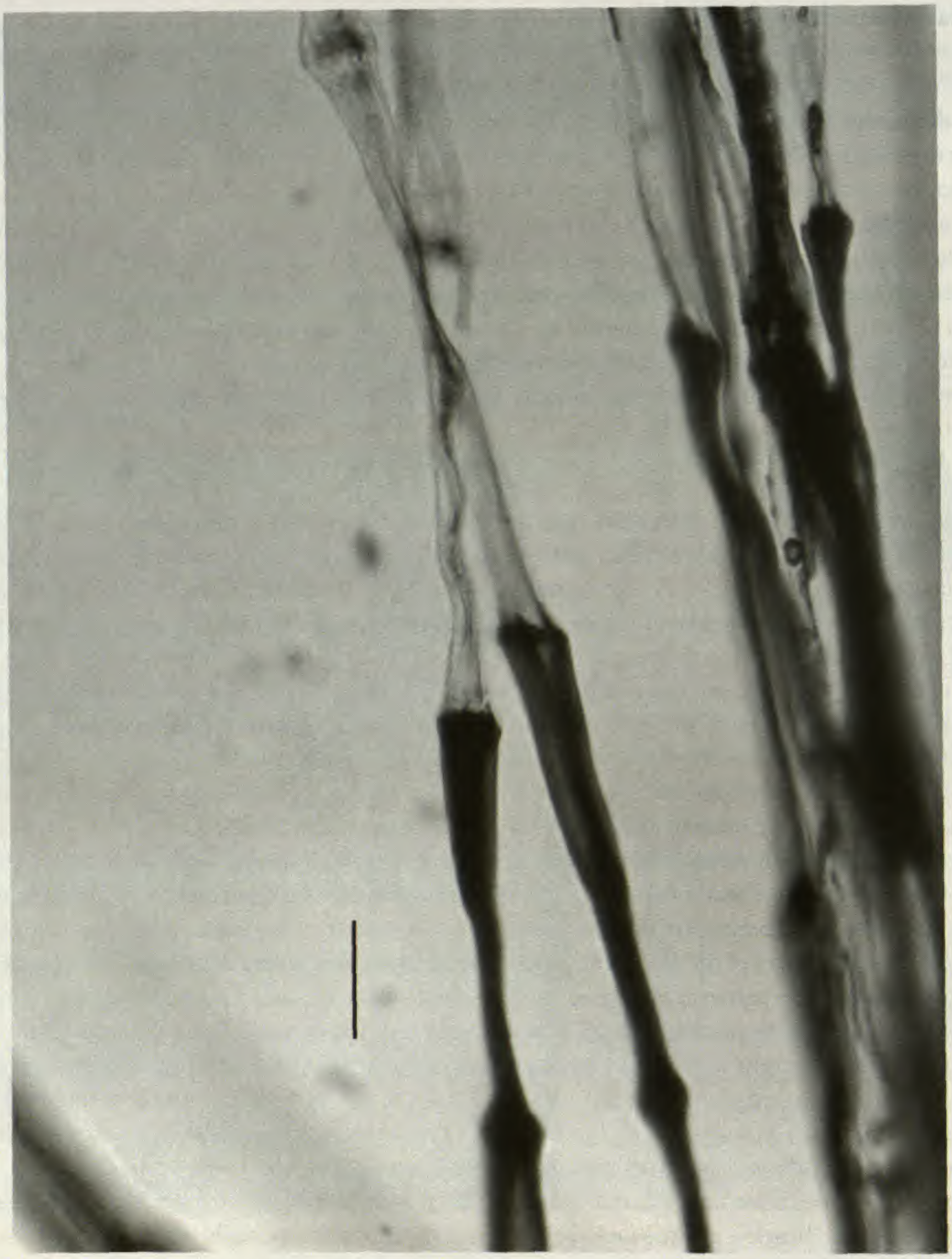

Fig. 3. Transition zone separating lower dark, thick-walled and upper, light, thin-walled cells forming the bristles of *Paleocharis nearctica* gen. and sp. nov. in Cretaceous Canadian amber. Scale bar = 53 µm.

The climate in Alberta during the Campanian Stage of the Late Cretaceous was subtropical to warm temperate. A large epicontinental sea divided North America and the resin-producing araucarians were not far from the Western bank of that sea (Braman & Koppelhuis 2005; Poinar & Poinar 2008; Smith et al. 1994). Based on chemical analysis, Canadian amber from Alberta was produced by araucarian trees, presumably belonging to the genus *Agathis*, commonly known as Kauri (Lambert et al. 1990). In the Waipoua araucarian forest of New Zealand, which is the only remaining virgin Kauri forest in the world, sedges, especially *Gahnia xanocarpa* (Hook.), are one of the dominant features of the undergrowth (Cockayne 1908; McGregor 1948). It is possible that *Paleocharis nearctica* was a common sedge in the undergrowth of the Canadian araucarian forest.

Fig. 4. Two micro-scales on the surface of the achene of *Paleocharis nearctica* gen. and sp. nov. in Cretaceous Canadian amber. Scale bar = 26 μm.

Table 1. Comparison of achene characters of *Paleocharis* with those of North American *Eleocharis*, *Rhynchospora* and *Eryophorum* (Flora of North America Editorial Committee 2002).

Character	Paleocharis	Eleocharis	Rhynchospora	Eriophorum
style base	enlarged, persistent, different in appearance from the achene	enlarged, persistent, usually different in appearance from the achene	enlarged, persistent, usually different in appearance from the achene	deciduous or only a small portion persistent
bristle number	>200	(0–)3–6(–10) or absent	2–12(–20) or absent	(8–)10–114
bristle type	straight, smooth, stiff	straight or curved, retrorsely (antrorsely) barbed or sometimes smooth	variously barbed or plumed, seldom smooth	straight, smooth, hairlike (rarely antrorsely barbed)

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REFERENCES

Berry, E.W. 1911. The flora of the Raritan Formation. Bull. Geol. Survey New Jersey 3:1–233.

Braman, D.R. and E.B. Koppelhuis. 2005. Campanian Palynomorphs. In: P.J. Currie and E.B. Koppelhus, eds. Dinosaur Provincial Park, A spectacular ancient ecosystem revealed. Indiana University Press, Indianapolis. Pp. 101–130.

Bremer, K. 2002. Gondwanan evolution of the grass alliance of families (Poales). Evolution 56:1374–1387.

Cockayne, L. 1908. Report on a botanical survey of the Waipoua Kauri Forest. John Mackay, Govt. Printer, Wellington.

Collinson, M.E., M.C. Boulter, and P.L. Holmes. 1993. Magnoliophyta ('Angiospermae'). In: M.J. Benton, ed. The Fossil Record-2. Chapman & Hall, London. Pp. 809–841.

Couper, R.A. 1953. Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand. New Zealand Geol. Survey Palaeont. Bull. 22:1–75.

Daghlian, R.M.T. 1981. A review of the fossil record of Monocotyledons. Bot. Rev. 47:517–555.

Eberth, D.A. and A.P. Hamblin. 1993. Tectonic, stratigraphic and sedimentological significance of a regional discontinuity in the Judith River Group (Belly River Wedge) of southern Alberta, Saskatchewan and northern Montana. Canad. J. Earth Sci. 30:174–200.

Flora of North America Editorial Committee. 2002. Flora of North America north of Mexico, Vol. 23. Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford University Press, New York.

Friis, E.W., W.G. Chaloner, and P.R. Crane (eds.). 1987. The origins of angiosperms and their biological consequences. Cambridge University Press, Great Britain

Goetghebeur, P. 1998. Cyperaceae. In: K. Kubitzki, H. Huber, P.J. Rudall, P.S. Stevens, and T. Stützel, eds. The families and genera of vascular plants Vol 4. Springer-Verlag, Berlin. Pp. 141–190.

Lambert, J.B., J.S. Frye, and G.O. Poinar, Jr. 1990. Analysis of North American amber by Carbon-13 NMR Spectroscopy. Geoarchaeology 5:43–52.

Lye, K.A. 2000. Achene structure and function in Cyperaceae. In: K.L. Wilson and D.A. Morrison, eds. Monocots: systematics and evolution. CSIRO Publishing, Melbourne. Pp. 615–628.

McKellar, R.C., A.P. Wolfe, R. Tappert, and K. Muehlenbachs. 2008. Correlation of Grassy Lake and Cedar Lake ambers using infrared spectroscopy, stable isotopes, and palaeoentomology. Canad. J. Earth Sci. 45:1061–082.

McGregor, W.R. 1948. The Waipoua Forest. The last virgin Kauri forest of New Zealand. Abel, Dykes, Limited, Auckland.

Poinar, Jr., G.O. and R. Poinar. 2008. What bugged the dinosaurs? Princeton University Press, Princeton, NJ.

Raven, P.H. and D.I. Axelrod. 1974. Angiosperm biogeography and past continental movements. Ann. Missouri Bot. Gard. 61:539–673.

Samylina, V.A. 1960. The angiosperms from the Lower Cretaceous of the Kolyma basin. Bot. Zhurnal SSSR 45: 335–352.

Saurer, J.D. 1988. Plant migration. University of California Press, Berkeley.

Simpson, M.G. 2006. Plant systematics. Elsevier Academic Press, New York.

Simpson, D.A., A. Muthama Muasya, M.V. Alves, J.J. Bruhl, S. Dhooge, M.W. Chase, C.A. Furness, K. Ghamkhar, P. Goetghebeur, T.R. Hodkinson, A.D. Marchant, A.A. Reznicek, R. Nieuwborg, E. Roalson, E. Smets, J.R. Starr, W.W. Thomas, K.L. Wilson, and X. Zhang. 2007. Phylogeny of Cyperaceae based on DNA sequence data—a new *rbcL* analysis. Aliso 23:72–83.

Smith, A.C., D.G. Smith, and B.M. Funnell. 1994. Atlas of Mesozoic and Cenozoic coastlines. Cambridge University Press, Cambridge.

Smith, S.Y., M.E. Collinson, D.A. Simpson, P.J. Rudall, F. Marone, and M. Stampanoni. 2009. Elucidating the affinities and habits of ancient, widespread Cyperaceae: *Volkeria messelensis* gen. et sp. nov., a fossil mapanoid sedge from the Eocene of Europe. Amer. J. Bot. 96:1506–1518.

Sweet, A.R. 1986. The Cretaceous-Tertiary boundary in the central Alberta foothills. II. Miospore and pollen taxonomy. Canad. J. Earth Sci. 23:1375–1388.

Woody-Plant Seed Manual. 1948. U.S. Department of Agriculture Miscellaneous Publication No. 654. U.S. Government Printing Office, Washington, D.C.

Zomlefer, W.B. 1994. Guide to flowering plant families. The University of North Carolina Press, Chapel Hill.

COLEATAENIA GRISEB. (1879): THE CORRECT NAME FOR *SORENGIA* ZULOAGA & MORRONE (2010) (POACEAE: PANICEAE)

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ABSTRACT

Twelve new combinations in *Coleataenia* Griseb. are proposed to replace those in *Sorengia* Zuloaga & Morrone.

RESUMEN

Doce nuevo combinaciones en *Coleataenia* Griseb se proponen para substituir ésos en *Sorengia* Zuloaga & Morrone.

The new genus *Sorengia* Zuloaga & Morrone, proposed in Zuloaga et al. (2010), is illegitimate, (Art. 52.1; McNeill et al. 2006), in that the type species of the genus *Coleataenia* Griseb. (1879) was included within one of the species of the new genus as a taxonomic synonym. *Coleataenia gynerioides* Griseb. (1879) was treated as a synonym of *Sorengia prionitis* (Nees) Zuloaga & Morrone. Twelve new combinations for the same taxa accepted in *Sorengia* by Zuloaga et al. (2010) are proposed here.

COLEATAENIA Griseb., "Symbolae ad Floram Argentinam," Abh. Königl. Ges. Wiss. Göttingen 24(1):308 1879. Type: *Coleataenia gynerioides* Griseb.

Sorengia Zuloaga & Morrone, Taxon 59(5):1541. 2010. Type: *Panicum agrostoides* Hitchc. & Chase.

Coleataenia anceps (Michx.) Soreng, comb. nov. Basionym: *Panicum anceps* Michx., Fl. Bor.-Amer. 1:48. 1803.

Coleataenia anceps subsp. **rhizomata** (Hitchc. & Chase) Soreng, comb. nov. Basionym: *Panicum rhizomatum* Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:109. 1910.

Coleataenia caricoides (Nees ex Trin.) Soreng, comb. nov. Basionym: *Panicum caricoides* Nees ex Trin., Gram. Pan. 149. 1826.

Coleataenia longifolia (Torr.) Soreng, comb. nov. Basionym: *Panicum longifolium* Torr., Fl. N. Middle United States 1:149. 1824.

Coleataenia longifolia subsp. **abscissa** (Swallen) Soreng, comb. nov. Basionym: *Panicum abscissum* Swallen, J. Wash. Acad. Sci. 30:215. 1940.

Coleataenia longifolia subsp. **combsii** (Scribner & C.R. Ball) Soreng, comb. nov. Basionym: *Panicum combsii* Scribner & C.R. Ball, Bull. Div. Agrostol., U.S.D.A. 24:42. 1901.

Coleataenia longifolia subsp. **elongata** (Scribn.) Soreng, comb. nov. Basionym: *Panicum agrostoides* var. *elongatum* Scribn., Bull. Agric. Exp. Sta. Univ. Tennessee 7:42. 1894.

Coleataenia longifolia subsp. **rigidula** (Bosc ex Nees) Soreng, comb. nov. Basionym: *Panicum rigidulum* Bosc ex Nees in Martius, Fl. Bras. Enum. Pl. 2:163. 1829.

Panicum agrostoides Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:100. 1910.

J. Bot. Res. Inst. Texas 4(2): 691 – 692. 2010

Coleataenia petersonii (Hitchc. & Ekman) Soreng, comb. nov. Basionym: *Panicum petersonii* Hitchc. & Ekman in Hitchcock, Man. Grasses W. Ind. 243, 263. 1936.

Coleataenia prionitis (Nees) Soreng, comb. nov. Basionym: *Panicum prionitis* Nees in Martius, Fl. Bras. Enum. Pl. 162. 1829.

Coleataenia gynerioides Griseb., Symb. Fl. Arg., Abh. Königl. Ges. Wiss. Göttingen 24:308. 1879.

Coleataenia stenodes (Griseb.) Soreng, comb. nov. Basionym: *Panicum stenodes* Griseb., Fl. Brit. W. Ind. 547. 1864.

Coleataenia tenera (Beyr. ex Trin.) Soreng, comb. nov. Basionym: *Panicum tenerum* Beyr. ex Trin., Mem. Acad. Imp. Sci. Saint-Petersbourg, ser. 6, Sci. Math., Seconde Pt. Sci. Nat. 3,1(2–3):341. 1834.

REFERENCES

McNeill, J., F.R. Barrie, H.M. Burdet, V. Demoulin, D.L. Hawksworth, K. Marhold, D.H. Nicolson, J. Prado, P.C. Silva, J.E. Skog, J.H. Wiersema, and N.J. Turland (eds). 2006. International code of botanical nomenclature (Vienna Code). Regnum Veg.146. A.R.G. Gantner Verlag KG.

Zuloaga, F.O., M.A. Scataglini, and O. Morrone. 2010. A phylogenetic evaluation of *Panicum* sects. *Agrostoidea, Megista, Prionita* and *Tenera* (Panicoideae, Poaceae): Two new genera, *Stephostachys* and *Sorengia*. Taxon 59:1535–1546.

CONGRUENCE BETWEEN ALLOMETRIC COEFFICIENTS AND PHYLOGENY IN STIPOID GRASSES: AN EVO-DEVO STUDY

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ABSTRACT

There is a strong, highly significant relationship between relative growth rates, in Stipoid grasses, as represented by allometric coefficients, derived from one set of spikelet variables, and a phylogenetic classification derived from an independent set of variables. Differences among allometric coefficients can be related to the specific histogenetic events underlying grass development. A relationship between ontogeny and phylogeny argues for a causal connection between the two, a connection that is thermodynamic in nature. In ontogeny there is the generation of information, i.e., matter transformation, which accompanies energy dynamics in organisms as they develop. In species information is generated through the appearance of unique developmental events in individuals in the species as well as genetically, i.e., mutation, recombination and chromosomal changes. In both instances the generation of this information is historically constrained. The information system of a species is virtual, known only through its effect on the organisms that appear. Also, this virtual information means the information produced when an individual develops is just a small subset of the potential information. As the information system of a species expands through unique developmental and genetic events, it becomes unstable leading to speciation.

RESUMEN

Hay una relación fuerte, altamente significativa entre las tasas de crecimiento relativo, en gramíneas estipoides, como las representadas por coeficientes alométricos, derivados de un conjunto de variables de la espiguilla, y una clasificación filogenética derivada de un conjunto independiente de variables. Las diferencias entre coeficientes alométricos pueden relacionarse con eventos específicos histogenéticos del desarrollo de las gramíneas. Una relación entre ontogenia y filogenia aboga por una conexión causal entre las dos, una conexión que es de naturaleza termodinámica. En la ontogenia existe la generación de información, ej., transformación de la materia, que acompaña a la dinámica de la energía en los organismos mientras se desarrollan. En las especies la información se genera mediante la aparición de eventos de desarrollo únicos en individuos de las especies así como asgenéticamente, ej., mutación, recombinación y cambios cromosomáticos. En ambas instancias la generación de esta información está constreñida históricamente. El sistema de información de una especie es virtual, conocida sólo por sus efectos en los organismos en los que aparece. También, esta información virtual significa que la información producida cuando un individuo se desarrolla es sólo un pequeño subconjunto de la información potencial. A medida que el sistema de información de una especie se expande mediante eventos genéticos y de desarrollo únicos, se hace inestable dando lugar a la especiación.

INTRODUCTION

The idea of a relationship between evolution and development is as old as evolution itself (Gilbert 2003) even used by Darwin (1859) as evidence for unity of type (Gilbert 2003). In the middle of the 20th century the rise of the Modern Synthesis resulted in genetics supplanting development as an explanatory phenomenon and it was argued that genetics and not development held the key to evolution (Gilbert 2003). In spite of genetic ideas coming to dominate in evolutionary studies, a relationship between development and evolution was not abandoned. For example, evolution, as descent with modification, formed the conceptual basis in attempts to understand the basic structure of the flower (e.g., Barnard 1957, 1960; Tepfer 1953; Tucker 1959) or of vascular plants in general (Meeuse 1966). Gould's *Ontogeny and Phylogeny* (1977) emphasized the relationship between the two phenomena and stimulated studies wherein evolutionary change was described in terms of modified allometries (see e.g., Gibson & Diggle 1997). There were also attempts to link evolution and development through emphasizing the developmental changes that have occurred with evolution (see McMahon & Hufford 2002; Olson 2003; Richards et al. 2006 and references therein). Still another approach to linking development and evolution described the changes in relative frequency of histogenetic events, e.g., cell division and enlargement, that occur with evolution (Kam & Maze 1974; Maze et al. 1972; Stebbins 1967).

J. Bot. Res. Inst. Texas 4(2): 693 – 704. 2010

Three developments in biology led to a renewed interest in the relationship between evolution and development (Gilbert 2003). One was the ability to infer more precise phylogenetic relationships based on numerical analyses of molecular data (Soltis et al. 2000). The second was the identification of genes involved in the development of organisms. Once these genes were known mutations in them could be used to determine their role in developmental processes, such as the nature (see Friedman et al. 2004; Meyerowitz 2002) or positioning (Smith et al. 2006) of appendages. In addition information was obtained on how genetically mediated changes affected growth rates which, in turn, are expressed phenotypically as changes in size and shape (Coen et al. 2004; Langlade et al. 2005; Rolland-Lagan et al. 2005). The third development resulted from re-evaluation of basic precepts and led to a conclusion of "..the inability of the neoDarwinian synthesis to account for many phenomena of higher-level phenotypic organization" (Müller & Newman 2005a). Similar arguments were presented in Maze & Finnegan (2008).

Modern studies in evolutionary development (evo-devo) include those which address the incorporation of developmental traits, either structural (see Olson 2003; Friedman et al. 2004) or molecular (Arendt 2003) in established phylogenetic trees or the genetic changes underlying adaptation (Hoekstra & Coyne 2007). Evo-devo arguments have also been used to explain the origin of novelty as being the result of environmentally induced developmental events (Müller & Newman 2005b; West-Eberhand 2005) that become incorporated into the DNA. Jablonka & Lamb (1995) and Steele et al. (1998) have also argued for the incorporation of environmentally induced traits. Pigliucci (2007), as well, has raised the question of the necessity of an extended evolutionary synthesis which incorporates environmental changes more directly into accounts of evolutionary change.

Another series of studies linking evolution and development are those seeking a common underlying cause in this case in non-equilibrium thermodynamics and information theory (Maze 1999; Maze et al.. 1990, 2001a,b, 2002, 2003a,b› 2005; Robson et al. 1993). In these studies it was reasoned that the morphological changes that occur with both evolution and development are the result the transformation of matter, i.e., the production of information, through which energy dynamics are carried out. This is seen, for example, in the production of high energy compounds such as ATP and NADH or carbohydrates, cellulose, secondary metabolites and proteins. The basic argument is that as matter is transformed during development it can be understood as information, "in-formed matter". This new morphological organization of information becomes part of the totality of information that delineates a species, i.e., its information system (Brooks, 2001, 2002; Brooks & Wiley 1988; Maze et al. 2005). This results in the expansion of the information system due to matter transformation and that, along with the addition of new information through genetic mutation and recombination, results in an increase in the complexity of the information system of a species. Once the information system of a species reaches a certain stage of complexity it bifurcates, expressed biologically as speciation (Brooks, 2001; Brooks & Wiley 1988). This view of speciation, admittedly a unique one, has been tested and verified (Maze et al. 2005).

Here I take a different approach to the study of evolution and development, a comparison of the relationships inferred from a phylogeny with the relationships inferred from an analysis of growth phenomena represented by allometric coefficients. There is no doubt that there is some sort of relationship between allometric coefficients and evolutionary change (Coen et al. 2004; Langlade et al. 2005; Rolland-Lagan et al. 2005); see also Gould (1977). But, what is the nature of that relationship beyond the truism that taxa differ in their allometric coefficients? Specifically I explore the idea there is some sort of predictability between allometric coefficients and phylogeny. In other words, by knowing one, e. g., allometric coefficients, can some sort of predictive statement be made about phylogeny? A predictive relationship between allometric coefficients and phylogeny is of interest as it may indicate some deep-seated underlying cause such as was argued by Maze (1999); Maze et al. (1990, 2001a,b, 2002, 2003a,b› 2005) and Robson et al. (1993).

MATERIALS AND METHODS

Plants. The plants used in this study are grasses in the genus *Achnatherum*, tribe Stipeae (Poaceae: Pooideae).

They are: *A. lemmonii* (Vasey) Barkworth, *A. nelsonii* (Scribner) Barkworth, *A. occidentale* (Thurb. ex S. Wats.) Barkworth, *A. hendersonii* (Vasey) Barkworth and *A. wallowaense* Maze and Robson; the specific collections are in Table 1. All are indigenous to western North America (Hitchcock, et al., 1969). The first three are wide-spread; the last two are more restricted in distribution; *A. hendersonii* occurs in central Washington and central Oregon, *A. wallowaense* in central and northeastern Oregon. These two species grow only in scattered sites where a very shallow, ca. 15 cm to bedrock, soil is subject to frost-heaving and at least one, *A. hendersonii* appears to be adapted to such a habitat as a result of the combination of a slower growth rate (Binney & Bradfield 2000) and unique root structure (Maze 1981). Similar studies have not been done on *A. wallowaense* but its close relationship between *A. hendersonii* and its occurrence in a similar habitat make me believe its growth and root structure would be the same as *A. hendersonii*.

The plants studied were collected from natural populations and not from a common garden. The latter would be desirable as a means of minimizing environmentally induced morphological variation but I lack the resources to establish such. Also, even though plants may be grown in a common garden the environmental factors that may cause differences among plants can not be completely eliminated; a common garden cannot eliminate all micro-environmental variation due to heterogeneity in the size of soil particles or the distribution of chemicals, water or other organisms, particularly microorganisms. This problem might be alleviated with random plots but the sample sizes required for this study preclude that. Second, interpreting the response of *A. hendersonii* or *A. wallowaense* in a common garden would be difficult because their native habitat is so odd. The ideal, of course, would be reciprocal transplant experiments but it is unlikely that *A. occidentale*, *A. nelsonii* and *A. lemmonii* could survive the solifluction seen in the habitats where *A. wallowaenes* and *A. hendersonii* occur.

The basic units of collection were individual plants and 47 spikelets were measured from each. The individuals were, in turn, organized into populations of 8–12 individuals and the populations into species of 2–6 populations per species. The number of individuals per populations and populations per species was the result of the sampling method required to do this study. To make a statistical comparison between allometric coefficients and a phylogeny I generated several sets of allometric coefficients for each species. This, in turn, requires enough spikelets to assure the calculated allometric coefficients were stable and not artifacts of small sample size. For details see analyses. 7473 spikelets were measured for this study.

The grasses studied here offer certain advantages. First, having one floret per spikelet, the structure and its parts are easy to identify and measure thereby assuring that homologous variables were being measured. Second, there is a body of developmental data on the Stipeae (Kam 1974; Kam & Maze 1974; Maze et al. 1971, 1972; Mehlenbacher 1970) which allows for connections to be made between allometric coefficients and histogenetic events that occur during ontogeny.

Variables. Five variables were measured for each spikelet: length of the two glumes, floret length and width and awn length, variables adequate to describe the spikelets. The relatively restricted set of variables was the result of a tradeoff between spikelet description and the number of spikelets necessary to make the required calculations . The results from these five variables are the same as those from a more expanded set of variables in another study on the Stipeae that also included the width of the glumes (Maze et al. 2003b).

Allometric coefficients. The first step in generating allometric coefficients was, for each species, to do a series of PCAs on a variance/covariance matrix of $\log_{10}$ transformed variables. The first eigenvectors of such an analysis is a vector of allometric coefficients (Jolicoeur & Mosimann 1960) that describe the relationship between each variable measured and the first PCA axis. These allometric coefficients represent a measure of the relationship between development of the variable measured and time, as represented by the first PCA axis (Jolicoeur & Mosimann 1960). There are a couple of problems with this approach. First, it is mature structures that are measured and not their development. Second, a first PCA axis, often a size axis, is not a perfect substitute for time. However, in a study like this these problems must be acknowledged, lived with and adjusted for. The demands of sample size preclude directly assessing developmental time which requires sections of spikelets at various stages of development. There are four problems with doing

TABLE 1. Species and collections used. Numbers by acronym for each collection, number of individuals measured.

Achnatherum lemmonii

LEMENT1–8. 28.3 km n Enterprise on Oregon State Highway 3, Wallowa Co., OR, U. S. A.; plants growing in forest of ponderosa pine and Douglas fir. 45.80 N, 117.21W. 9 Jul 1998

LEMCOLO1–8. just across Kittitas-Chelan Co. line in Kittitas Co. along Colockum Pass Road, WA, U. S. A.; plants growing in an open stand of ponderosa pine. 47.50N, 120.19W. 13 Jun 2002.

LEMFOX1–8. 7 km from U. S. Forest Service Road 4240 on road 200, Crook Co., OR, U. S. A.; plants in deep soil in among ponderosa pine. 44.16N, 120.10W. 15 Jun 2002.

LEMIND1–8. 15.8 km s. Foothill Road on Indian Springs Road, Twin Falls., Co., ID, U. S. A.; plants growing among shrubs in rolling hills. 42.34N, 114.57W. 11 Jun 2004.

LEMSIE1–8. 2.4 km. s. of Graeagle on Calif. St. Highway 89, Plumas Co., CA, U. S. A.; plants growing with ponderosa pine. 39.45N, 120.37W. 18 Jun 2004.

LEMCLR1–6. 1 km. W. of Calif. St. Highway 89, On Clark Creek Road, Shasta Co., CA, U. S. A.; plants growing with Quercus kellogii and ponderosa pine. 41.15N, 121.72W. 19 Jun 2004.

Achnatherum hendersonii

HENCOL1–8. along Tarpescan Creek Road where it joins Colockum Pass Road, Kittitas Co., WA, U. S. A.; plants growing in shallow soil in sparse vegetation. 47.47N, 120.20W. 13 Jun 2002.

HENFOX1–8. 7 km from U. S. Forest Service Road 4240 on road 200, Crook Co., OR, U. S. A.; plants growing in shallow soil in sparse vegetation. 44.30N, 120.20W. 15 Jun 2002

Achnatherum wallowaense

WALBON1–8. near Boner Springs, middle sw ¼ of se ¼ of section 24, T3N, R45E., Wallowa-Whitman Nat. For., along FS Road 46, Wallowa Co, OR, U. S. A.; plants growing in shallow soil in sparse vegetation. 45.67N X 117.13W. 26 Jun 1993.

WALSKO1–8. middle of section 9, T12S, R18E, Ochoco N. F., Crook Co., OR, U. S. A.; plants growing in shallow soil in sparse vegetation. Site 30011 USDA Forest Service R-6 Threatened, Endangered and Sensitive Plant Surveys. 44.53N X 120.60W, 28, 29 Jun 2003.

Achnatherum occidentale

ELMSIE1–10. 2.4 km. s. of Graeagle on Calif. St. Highway 89, Plumas Co., CA, U. S. A.; plants growing with ponderosa pine. 39.45N, 120.37W. 1 Jun 2001.

ELMBUL1–8. growing along old road just n. of Bull Mountain near cattle guard on Forest Service Road 2730, 2 miles from Forest Service Road 27, Ochoco National Forest, Crook Co. OR, U. S. A. 44.51N, 120.60W. 15 Jun 2002.

ELMCOL1–8. along west bank Columbia River just north of bridge carrying U. S. Highway 395 across the Columbia River, Stevens Co., WA, U. S. A.; plants growing with ponderosa pine. 48.63N, 118.13W. 18 Jun 2002.

ELMMON1–8. n. side Power House Road, just across U. S. Highway 395 on the west bound extension of Calif. St. Hiway 167, Mono Co., CA, U. S. A.; plants growing in sage brush. 38.05N, 119.17W. 17 Jun 2004.

ELMOLD1–8. 1.6 km sw junction California State Highways 44 and 89 on 89, near Old Station, Shasta Co., CA, U. S. A. 40.68N, 121.30W. 19 Jun 2004.

Achnatherum nelsonii

NELWL1–14. from 1.1 km w. of Highway 97 on White Lake Road, s. of Pentiction B. C., Canada; plants growing open area with ponderosa pine. 49.42N, 119.64W. 8 Jun 2001.

NELCOL1–8. from along west bank Columbia River just north of bridge carrying U. S. Highway 395 across the Columbia River, Stevens Co., WA, U. S. A.; plants growing with ponderosa pine. 48.63N, 118.13W. 18 Jun 2002.

NELENT1–3. from 28.3 km n Enterprise on Oregon State Highway 3, Wallowa Co., OR, U. S. A.; plants growing in forest of ponderosa pine and Douglas fir. 45.80 N, 117.21W. 9 Jul 1998

NELANA1–8 *A. nelsonii* from rest stop on Anacharist Mt. Along Highway 3, British Columbia, Canada. 49.02N, 119.37W. Jun 2002.

NELMAN1–8 growing in gravel patch in parking lot at start of Beaver Pond Nature Trail, Manning Prov.Park, British Columbia, B. C., Canada. 49.06N, 120.75W. 3 Jul 2004

that. First, it would mean that the number of spikelets from an individual that could be measured is limited since the direct assessment of time demands destructive sampling. Second, this would be extremelhy time consuming since the preparation of spikelets of different ages requires the production of a large number of microscope sections. Third, the lack of synchrony between developmental stages in the Stipeae (Maze et al. 1971, 1972) would introduce a problem in comparing spikelets of different ages. Fourth, the inability of get sections that could be easily measured means that far less data could be gathered.

In order to make comparisons between development, as represented by allometric coefficients, and phylogeny, as represented by a phylogenetic classification I had to represent each species using allometric coefficients as variables. That is easily done, do the required PCA for each species, take the first eigenvector and then transpose it from a vector into a row of five variables where each variable, say first glume length, is represented by its allometric coefficient. But it would be inappropriate to do a single PCA for each species. Such would result in a data set with only five cases, one for each species, and five variables, the allometric coefficients for the five features measured. Such a small data set is of little use in a comparison with the results of a phylogenetic analysis since it is too small of a data set to produce meaningful results. Thus, to generate a population of allometric coefficients for each species, I randomized all the spikelets within each species, divided that randomized data set into groups of 94 spikelets each and did a PCA on each of those groups. This meant that there were from 8 PCAs, for *A. hendersonii* and *A. wallowaense*, 20 for *A. occidentale*, 21 for *A. nelsonii* and 23 sets for *A. lemmonii*. Each group of 94 was checked to assure that all individuals and populations collected for each species were included within it. A group size of 94 was chosen to assure analytical stability, i.e., that the results were not an artifact of small sample size.

The randomization of spikelets was a choice made on developmental considerations. Allometric coefficients for any set of spikelets are a numrical summary of the developmental events of the spikelets in that set. Those developmental events will be the result of the genomic instructions for development and the interactions between that genome and the environment it experiences during development. That environment has both external and internal components. The external environmental factors producing an effect would be the likes of the continually changing day length, temperature, moisture, soil and neighboring organisms that a developing plant experiences. The internal environment is established by the distribution of growth promoting and inhibiting substances, e.g., hormones. The complexity of the internal environment can be traced to the continually changing sources of growth effecting substances as growth centers appear and disappear. The purpose of data randomization was to neutralize the effect of the genotype of any one individual as well as any environmental effect on calculated allometric coefficients. Each 94 spikelet sample included spikelets from all individuals and populations. Thus, any one of the sets would not have spikelets that have all been subjected to similar environmental, both internal and external, or genetic effects. This lowers the probability that any one PCA was biased because of an asymmetric distribution of environmental influences.

As a result of the randomization within each species, subdividing of the data for each species into groups of 94 spikelets and submitting each group to PCA, I generated an 80 x 5 matrix. Each of the 80 cases represents the results of one PCA of the randomized 94 spikelets and the five variables were the allometric coefficients i.e., the elements in first eigenvector for that PCA. The allometric coefficients were compared with each other using the Kolomogorov-Smirnov test of variables. This is a test to determine if two variables have a similar distribution as based on a distance function. This distance statistic was used to evaluate the relationship among the allometric coefficients, a small distance indicating a similar distribution is taken as evidence the allometric coefficients for the variables are similar. The similarity and differences among the allometric coefficients were then evaluated by relying on the ontogenetic events whereby the different variables develop. Variables with similar allometric coefficients would be expected to show similar ontogenetic events, e.g., patterns of cell division and maturation in comparable tissues.

Phylogenetic analyses. The phylogenetic analyses were based on 19 variables of both vegetative and reproductive features (Table 2). To avoid analytical redundancy variables that described the features similar to those used to calculate allometric coefficients were not included in the phylogenetic analysis. Although there were only five species subjected to phylogenetic analysis, I wanted to be sure the phylogenetic signal was strong, i.e., that the data describing the five species was sufficiently stable to give the same results regardless of outgroup. To that end, four species were used as outgroups, *Hesperostipa comata* (Trin. & Rupr.) Barkworth, *Nasella viridula* (Trin.) Barkworth, *Achnatherum lettermanii* (Vasey) Barkworth and *A. hymenoides* (Roem. & J.A. Schult.) Barkworth. The first two species are, like *Achnatherum*, in the Stipeae and, at one

TABLE 2. Characters used for phylogenetic analysis and their codes.

1	Height: >4 dm – 0, <4 dm – 1
2	Sheath: not villous at throat – 0, villous at throat – 1
3	Ligule: acuminate – 0, acute – 1, collar shaped – 2
4	Blade length: >8 cm – 0 <8 cm – 1
5	Blade width: >3.5 mm – 0, 3.4 to 1 mm – 1
6	Inflorescence shape: open – 0, closed - 1
7	Inflorescence length: >8 cm – 0, < 8 cm – 1
8	Inflorescence branches: stiff – 0, lax – 1
9	Glume shape: narrow – 0, wide – 1
10	Glume tip: strongly acuminate – 0, acuminate – 1, acute – 2
11	Lemma: thin – 0, indurate – 1
12	Lemma apex: straight – 0, angled – 1
13	Callus shape: curved – 0, straight - 1
14	Callus length: >3 mm – 0, 3 to 1 mm – 1, <1mm – 2
15	Callus tip: sharp – 0, blunt – 1
16	Awn pubescence: scabrous to hirtellous – 0, long pubescent – 1
17	Awn persistence: persistent – 0, tardily deciduous – 1, deciduous – 2
18	Palea:lemma: subequal – 0, shorter – 1
19	Palea pubescence: pubescent – 0, glabrous – 1

time were congeneric, as *Stipa*, with four of the five species, *A. lemmonii*, *A. occidentale*, *A. hendersonii* and *A. nelsonii*, studied here. The other two are more closely related to the five species studied here. Single species were used to polarize the data since doing so meant that a larger set of variables could be used in constructing a phylogeny than if a genus or other group of closely related species was used to polarize the data. Phylogenetic analyses were performed with Phylogenetic Analyses Using Parsimony (PAUP) Version 4.0 b10.6 (Sinauer Associates Inc. Sunderland, MA) using an exhaustive search with equal character state weighting. It would be desirable to use molecular data, but molecular data is available for only a limited set of the species used here (Jacobs et al. 2000).

All the separate phylogenetic analyses that were produced using the four different outgroups recognized the same three lineages, one consisting of *A. nelsonii* and *A. occidentale*, another of *A. hendersonii* and *A. wallowaense* and the third being the pair *A. hendersonii* and *A. wallowaense* along with *A. lemmonii*. These groupings are consistent with existing data. *Achnatherum nelsonii* and *A. occidentale* are putatively closely related and have been considered, in the past, to be varieties of one species (Hitchcock et al., 1969). *Achnatherum lemmonii* and *A. hendersonii* share some unique developmental features including obliquely directed tissue at the apex of the lemma resulting from periclinal divisions in the protoderm producing an oblique floret apex, an extension of the outer integument that projects into the stylar canal and a distinctive pattern of cell enlargement in the callus (Maze et al. 1972; Mehlenbacher 1970). *Achnatherum wallowaense* has not been studied developmentally but the strong morphological similarity between it and *A. hendersonii* (small indurate, glabrous floret with a blunt callus, oblique floret apex, long palea and weak, easily deciduous awn) makes me suspect it has similar developmental features. A close relationship between *A. lemmonii* and *A. hendersonii* was reported by Jacobs et al. (2000). The same would be indicated by the hybrids formed between those two species (Spellenberg & Mehlenbacher 1971).

In order to compare the results of a phylogenetic analysis with allometric coefficients for the five species included in that phylogenetic analysis I generated a data matrix to describe the evolutionary structure inferred by the phylogenetic analysis. This data matrix consisted of three dummy variables and 80 cases, the same number of cases as in the data matrix of allometric coefficients. One dummy variable described the lineage consisting of *A. wallowaense* and *A. hendersonii*, another that consisting of *A. occidentale* and *A. nelsonii*, and the third the lineage of *A. lemmonii*, *A. hendersonii* and *A. wallowaense*. This matrix was joined to the matrix of allometric coefficients and the values ascribed to those dummy variables was determined

by the species in the matrix of allometric coefficients. The dummy variable that recognized the lineage consisting of *A. hendersonii* and *A. wallowaense* was given a value 2 for those instances where those two species in were positioned in the data matrix of allometric coefficients. Where the remainder of the species were positioned in the data matrix of allometric coefficients that dummy variable was given a value of 1. The value for the dummy variable used to represent the lineage consisting of *A. occidentale* and *A. nelsonii* was established in the same way; that variable was coded as 2 where those species were positioned in the data matrix of allometric coefficients and as 1 for the position occupied by the remainder of the species, *A. lemmonii*, *A. hendersonii* and *A. wallowaense*. The third dummy variable that represented the lineage consisting of *A. lemmonii*, *A. hendersonii*, and *A. wallowaense* was coded in the same way; it was given a value of two where those three species were positioned in the data matrix of allometric coefficients and a value of 1 elsewhere. An example of this matrix of dummy variables along with the species names is in Table 3.

Comparison. The first step in comparing the allometric coefficients with the phylogenetic classification was to summarize the data with principal components analysis (PCA). One PCA was done on the 80 x 5 data matrix of allometric coefficients and the other on the 80 x 3 matrix of dummy variables used to describe the phylogenetic classification. The results of the two PCAs were compared with a Spearman rank correlation coefficient. Only first PCA axes were compared since they are the best descriptors of the data. This approach gives a single number, statistical in nature, summarizing the relationship between development and evolution. A Spearman rank correlation coefficient was chosen because all the numerical manipulations I used made me leery of using a parametric statistic.

All analyses were done using SYSTAT 4.0 (Wilkinson 1991).

RESULTS

Table 4 presents a comparison of the allometric coefficients for the five species as a Kolomogorov-Smirnov test of variables. This statistic is a distance measure evaluating the distributions of the variables being tested. The distributions for the allometric coefficients for glume length have a distance that is not statistically significant. The distributions for all other pairs of variables have distances that are statistically significant. I interpret a statistically significant distance as an indication that the two variables are the result of events linked to their developmental history. I also did a Spearman rank correlation on the allometric coefficients. That is not shown but gave comparable results, the allometric coefficients for the lengths of the two glumes were the most strongly correlated.

The Spearman rank correlation coefficient between the PCA axis scores summarizing the allometric coefficients and the PCA axis scores summarizing the phylogenetic classification is .790, $p<<<<.001$; the allometric coefficients and phylogenetic classification are strongly congruent, they are giving similar signals. As a test of this approach I produced four other matrices of dummy variables describing classifications different from that inferred by the phylogenetic classification. The Spearman rank correlation between those four alternate classifications and the allometric coefficients were 0.030, -0.137, 0.579 and 0.413, all lower than the original test.

DISCUSSION

The similarity between the allometric coefficients for the length of the two glumes is hardly surprising. Although not all the species included here have been studied developmentally, those that have, *A. hendersonii* (Mehlenbacher 1970) and *A. lemmonii* (Maze et al. 1972), show very similar patterns in initiation and growth of the glumes. As well, the glumes of other Stipeae in which development has been described (Maze et al. 1971; Kam 1974; Kam & Maze 1974) are like *A. hendersonii* and *A. lemmonii*. The glumes are little more than acute to acuminate flaps of tissue without striking cellular differentiation in them other than relatively simple epidermis, parenchyma and vascular tissues.

The dissimilarity in allometric coefficients for all the other spikelet structures measured is, likewise, not surprising. Floret length, as measured here, is developmentally complex. One aspect of floret length,

TABLE 3. Abbreviated matrix of dummy variables that describe the evolutionary structure based on the phylogenetic classification. Species, the species in the data matrix of allometric coefficients, (number) is the number of cases for each species; LWH, dummy variable for lineage consisting of *A. lemmonii*, *A. wallowense* and *A. hendersonii*; NO, dummy variable for lineage consisting of *A. occidentale* and *A. nelsonii*; HW, dummy variable for lineage consisting of *A. hendersonii* and *A. wallowense*.

Species	LWH	NO	HW
Achnatherum lemmonii (23)	2	1	1
Achnatherum hendersonii (8)	2	1	2
Achnatherum wallowaense (8)	2	1	2
Achnatherum occidentale (20)	1	2	1
Achnatherum nelsonii (21)	1	2	1

TABLE 4. Kolmogorov-Smirnov two sample test results. Maximum differences for pairs of variables. G1L, length first glume; G2L, length second glume; FL, floret length; FW, floret width; AWN, awn length. ns, differences not significant; *, differences significant p<.05 >.01; ** p<.01 >.001; *** p<.001.

	G1L	G2L	FL	FW
G2L	0.188^{ns}			
FL	0.500^{***}	0.338^{***}		
FW	0.262^{**}	0.275^{**}	0.463^{***}	
AWN	0.325^{***}	0.350^{***}	0.637^{***}	0.250^{*}

the length of the lemma, is part of the integrated growth which leads to both the awn and the lemma. The first thing to initiate will become the awn, the tissue that will become the lemma appears after the awn when the awn-lemma primordium begins to spread around the floret apical meristem to form the lemma (Kam & Maze 1974 and references therein). Another developmental feature captured in floret length is the callus. This is marked by a unique, and often extensive, pattern of cell enlargement slightly oblique to the longitudinal axis of the floret, at the base of the floret leading to a projection (Maze et al. 1971, 1972; Mehlenbacher 1970; Kam 1974; Kam & Maze 1974) within which the cells are heavily sclerified. Cells of the lemma, especially in *A. hendersonii* and *A. wallowaense* and to some extent in *A. lemmonii* are also sclerified. Even though that feature was not measured here, it offers another demonstration of the developmental complexity of the floret.

Awn length, too, is developmentally complex; the awn is the first thing initiated in the formation of the floret and its differentiation from the lemma occurs later in development. Its growth in length is a combination of cell division, apically early in its development and sub-apically later, and cell enlargement, which appears first in apical cells. Growth in length is limited leading to the shorter awns in *A. hendersonii* and *A. wallowaense*; growth in awn length is greater in *A. occidentale*, *A. nelsonii* and *A. lemmonii*. Another contributor to the developmental complexity of the awns of the Stipeae is the sclerenchyma with eccentric lumens that surrounds the vein in the awn (Maze 1972). This tissue is implicated in the twisting and straightening of the awn of the Stipeae with hydroscopic changes (Murbach 1900) and is much better developed in *A. lemmonii*, *A. occidentale* and *A. nelsonii*. As a further indication of the developmental intricacy in the awn of the Stipeae, in those awns with well developed sclerenchyma it starts to differentiate much earlier than surrounding tissues (Maze et al. 1971).

Floret width, also, is developmentally complex since it is the result of two developmental events, the spread of the awn-lemma primordium around the floret apical meristem followed by subsequent marginal growth in the lemma. That marginal growth is made more complex through the thickness of the lemma, the result of periclinal divisions in what could be called the flank meristem of the developing lemma margins.

A strong correlation between allometric coefficients, representing ontogeny, and a phylogenetic classification, representing evolutionary history, argues for a relationship between the two phenomena. It is

tempting to resurrect the idea of a causal relationship between ontogeny and phylogeny (see Gilbert 2003 & Lovejoy 1959 for a history of such ideas). However, there is a problem with such an argument, the conceptual and empirical gap between the idea of a causal relationship between ontogeny and phylogeny and the currently popular mechanism proposed for evolution, natural selection favoring certain non-directed (often called random) variants, is large. And the idea of ontogeny driving phylogeny does not enjoy a well-established mechanism, even in most modern evo-devo studies that stress how those changes occur or the description of those changes.

But, such a disconnect is not a part of all modern evo-devo studies. Müller and Newman (2005b) and West-Eberhard (2005) argue for environmentally induced developmental events as the origin of novelty. There are a couple of interesting points from their argument. First, Darwin (1859) posited at the origin of at least some variation as from the conditions of existence, i.e., the environment, as did Lamarck (1809). Second, the ideas of West-Eberhard (2005) and Müller and Newman (2005b) would seem to be an expression of Waddington's (1953) genetic assimilation or the Baldwin effect, i.e., the incorporation of plastic traits into DNA. Recently Pigliucci and Murren (2003) argued in favor of the Baldwin effect as a source of evolutionary change. Pigliucci (2007) has also argued for an extended evolutionary synthesis that includes such phenomena as phenotypic plasticity and epigenetic inheritance, both which have a developmental basis. And Jablonka and Lamb (1995) and Steele et al. (1998) have described putative molecular mechanisms whereby environmentally induced traits can be incorporated into the DNA. Other molecular mechanisms involve methylation of DNA, as well as other chemicals such as ethyl, acetyl and phosphoryl modifications of histones (Pray 2004).

Another potentially causal relationship between ontogeny and phylogeny has been presented by Maze et al. (2005), a view derived from the argument that species are information systems (see Brooks 2001, 2002, 2010; Brooks & Wiley 1988; Maze et al. 2005). But there is a depth to the Brooks view not captured in the modern epigenetic studies or the views of Pigliuccci cited above. Those studies stressed the here and now as expressed in the material existence of individuals while Brooks arguments see the material existence of the individual as representing only part of the potential information available to an individual. That potential information, I would argue, represents the information system of the species, an information system that has captured the history of the species and carries that history forward into the future.

I find it useful to envision the information system of a species as a code, analogous to the code in a computer, that captures all the various ways in which information is expressed in the individuals of that species. Like the code in a computer, the information system of a species is known to exist when there appears a specific response in the material world to a certain action. That action, in a computer, could be striking a key; in a species that action could be the events that stimulate and allow the production of an individual.

Information expression in a species is the result of events mediated by DNA in response to environmental stimuli, both internal and external. For example, all events, molecular, cytological, histological, leading to a periclinal division in the protoderm at the apex of a grass floret would become part of the information system of that species. The same would apply to all other similar events which occur as that plant develops. The argument that environmentally mediated ontogenetic changes contribute to an expanding information system can be seen as part of Darwin's condition of existence contributing to evolution (Brooks 2010). Natural selection, which emerges from the interaction of Darwin's nature of the organism and nature of the conditions (Brooks 2010), is important as it accounts for survival, a necessary prerequisite for evolution to occur, i.e., it is necessary but not sufficient for evolution to occur.

As a result of the information expression that accrues through ontogeny of an individual, the information system of the species to which that individual belongs would expand. Much of this expansion could be traced to variation in both internal and external environments that elicit slightly different responses from the cytoplasm which will, in turn, prompt a different response from the genome. The information system of a species would also expand as the result of genetic events, viz. mutation, chromosomal rearrangements and the recombination that accompanies sexual reproduction. As the information system of the species expands

through the appearance of unique developmental events and new arrangements of DNA it becomes unstable resulting in speciation (Brooks, 2001, 2002, 2010; Brooks & Wiley 1988).

This view incorporates a common causal element into ontogeny and phylogeny. This is seen as a two phase aspect with a direct phase affecting development of an individual and an indirect phase affecting evolution. In development the direct cause of the expansion of the information system of a species is the transformation of matter, the production of information. This production of information accompanies the energy dynamics of a developing organism; the transformation of matter is the means whereby energy is processed. I note in passing that it has been shown that an increase in the amount of energy under which grape leaves develop produces an increase in the diversity of allometric coefficients which also occurs with both ontogeny and phylogeny (Maze et al. 2003a).

The relation of information expression to energy dynamics in the ontogeny of an individual, the outcome of the second law of thermodynamics in a highly organized system, offers an indirect tie between energy dynamics and evolution. The increase in complexity of the information system of a species, an increase leading to speciation, is indirectly the result of energy dynamics that are the cause of ontogeny. This is not to say that events such as mutation and recombination do not contribute to the increase in the complexity of the information system of a species; they do and perhaps may be viewed themselves as a thermodynamic phenomenon, the increase in informational entropy with the appearance of new things. These ideas are the same as those arguments first presented by Brooks & Wiley (1988). However, these views do offer a common cause for ontogeny and phylogeny and, as argued by Maze et al. (2005), such views can offer an explanation, albeit a controversial one, for incipient speciation that occurs over geographic areas greater than those occupied by single populations.

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REFERENCES

Arendt, D. 2003. Evolution of eyes and photoreceptor cell types. Int. J. Dev. Bio. 47:5653–571.

Barnard, C. 1957. Floral histogenesis in the Monocotyledons. I. The Gramineae. Aust. J. Bot. 5:1–20.

Barnard, C. 1960. Floral histogenesis in the Monocotyledons. IV. The Liliaceae. Aust. J. Bot. 8:213–225.

Binney, E.P. and G.E. Bradfield. 2000. An initial comparison of growth rates in the rare grass *Achnatherum hendersonii* and its common associate *Poa secunda*. Ecol. Res. 15:181–185.

Brooks, D.R. 2001. Evolution in the information age: rediscovering the nature of the organism. Semotics, evolution, energy and development, 1(1), 1–26, University of Toronto Library, retrieved April 2010 from http://www.library.utoronto.ca/see/SEED Vol1-1

Brooks, D.R. 2002. Taking evolutionary transitions seriously. Semotics, evolution, energy and development 2, (1) 6–24, University of Toronto Library, retrieved April 2010 from http://www.library.utoronto.ca/see/SEED/vol2-1.

Brooks, D.R. 2010. The Mastodon in the room: How Darwinian is neo-Darwinism? Stud. Hist. and Phil. of Science (in press).

Brooks, D.R. and E.O. Wiley. 1988. Evolution as Entropy, 2nd ed. University of Chicago Press, Chicago.

Coen, E., A-G. Rolland-Lagan, M. Matthews, and J.A. Bangham. 2004. The genetics of geometry. Proc. Nat. Acad. Sci. 101:4728–4735.

Darwin, C. 1859. On the origin of species. J. Murray, London.

Friedman, W.E., R. Moore, and M.D. Purugganan. 2004. The evolution of plant development. Amer. J. Bot. 91: 1726–1741.

GIBSON, J.D. AND P.K. DIGGLE. 1997. Structural analysis of female and hermaphroditic flowers of a gynodioecious tree *Ocotea tenera* (Lauraceae). Amer. J. Bot. 84:298–307.

GILBERT, S. 2003. The morphogenesis of evolutionary developmental biology. Int. J. Dev. Bio. 47:467–477.

GOULD, S.J. 1977. Ontogeny and phylogeny. Harvard University Press, Cambridge, MS.

HITCHCOCK, C.L., A. CRONQUIST, M. OWNBEY, AND J.W. THOMPSON. 1969. Vascular plants of the Pacific Northwest. Part 1, Vascular Cryptograms, Gymnosperms and Monocotyledons. University of Washington Press, Seattle, WA.

JABLONKA, E. AND M.J. LAMB. 1995. Epigenetic inheritance and evolution: the Lamarckian dimension. Oxford University Press, Oxford.

JACOBS, S.W.L., J. EVERETT, M.E. BARKWORTH, AND C. HSIAO. 2000. Relationships within the Stipoid grasses (Gramineae). In: S.W. Jacobs and J Everett eds. Proceedings of the third international symposium in grass systematics and evolution. CSIRO, Canberra, Australia. Pp. 75–82.

JOLICOEUR, P. AND J. MOSIMANN. 1960. Size and shape in the painted turtle. A principal component analysis. Growth 24:339–354.

LAMARCK, J. 1809. Zoological Philosophy translated by Hugh Eliot (1963). Hafner Pub. Co., New York.

LANGLADE, N.B., X. FENG, T. DRANSFIELD, L. COPSEY, A.J. HANNA, C. THÉBAUD, A. BANGHAMN, A. HUDSON, AND E COEN. 2005. Evolution through genetically controlled allometry space. Proc. Nat. Acad. Sci. 102:10221–10226.

LOVEJOY, A.O. 1959. Recent criticism of the Darwinian theory of recapitulation: Its grounds and its initiator. In: B Glass, ed. Forerunners of Darwin 1745–1859. Pp. 428–458

KAM, Y.K. 1974. Developmental studies of the floret in *Oryzopsis virescens* and *O. hymenoides* (Gramineae). Canad. J. Bot. 52:125–149.

KAM, Y.K. AND J MAZE. 1974. Studies on the relationships and evolution of supraspecific taxa utilizing developmental data. II. Relationships and evolution of *Oryzopsis hymenoides, O. virescens, O. kingii, O. micrantha,* and *O. asperifolia*. Bot. Gaz. 135:227–247.

MAZE, J. 1972. Notes on the awn anatomy of *Stipa* and *Oryzopsis* (Gramineae). Syesis 5:169–171.

MAZE, J. 1981. A preliminary study on the root of *Oryzopsis hendersonii*. Syesis 14:151–154.

MAZE, J. 1999. Studies into abstract properties of individuals. III. A study of factors affecting emergence. Int. J. Plt. Sci. 160:809–817.

MAZE, J., S. BANERJEE, AND K.A. ROBSON. 2001a. Studies into abstract properties of individuals. VI. The degree of emergence in individuals, populations, species and a three species lineage. BioSystems 61:41–54.

MAZE, J., L.R. BOHM, AND C.E. BEIL. 1972. Studies on the relationships and evolution of supraspecific taxa utilizing developmental data. I. *Stipa lemmonii* (Gramineae). Can. J. Bot. 50:2327–2352.

MAZE, J., P. BOWEN, AND C. BOGDANOFF. 2003a. A study on the interplay between energy and matter transformation: the effect of elevated temperatures on the leaf morphology of *Vitis vinifera* var. Merlot. BioSystems 73:253–261.

MAZE, J., N.G. DENGLER, AND L.R. BOHM. 1971. Comparative floret development in *Stipa tortilis* and *Oryzopsis milacea* (Gramineae). Bot. Gaz. 132:273–298.

MAZE, J. AND C.V. FINNEGAN. 2008. Does Darwin's theory deserve theological support, and does evolution need Darwin's theory? Theology and Science 6:239–254.

MAZE, J., K.A. ROBSON, S. BANERJEE, L.R. BOHM, AND R.K. SCAGEL. 1990. Quantitative studies in early ovule and fruit development: developmental constraints in *Balsamorhiza sagittata* and *B. hookeri*. Bot. Gaz. 151:415–422.

MAZE, J., K.A. ROBSON, AND S. BANERJEE. 2001b. Studies into abstract properties of individuals. V. An empirical study of emergence in ontogeny and phylogeny in *Achnatherum nelsonii* and *A. lettermanii*. Semiotics, Evolution, Energy, Development 1(1), University of Toronto Library, retrieved June 2001 from http://www.library.utoronto.ca/see/SEED/Vol1-1/Maze-emergence.html.

MAZE, J., K.A. ROBSON, AND S. BANERJEE. 2002. Studies into abstract properties of individuals. VII. Emergence in *Hesperostipa comata* and three species of *Achnatherum* (Poaceae). Int. J. Pl. Sci. 163:379–385.

MAZE, J., K.A. ROBSON, AND S. BANERJEE. 2003b. Expanding the view of emergence in individuals, populations and species of Stipoid Grasses: a comparison including *Achnatherum occidentale*. Semiotics, Evolution, Energy, Development 3(1), University of Toronto Library, retrieved September 2003 from http://www.library.utoronto.ca/see/SEED/Vol3-1/Maze.doc.

MAZE, J., E. TABORSKY, AND C.V. FINNEGAN. 2005. The effect of species models on estimates of within-group variation in integration. BioSystems 80:185–192.

MCMAHON, M. AND L. HUFFORD. 2002. Developmental morphology and structural homology of corolla-androecium synorganization in the tribe Amorpheae (Fabaceae: Papilionoideae). Amer. J. Bot. 89:1884–1898.

MEEUSE, A.D.J. 1966. Fundamentals of Phytomorphology. Ronald Press, New York.

MEHLENBACHER, L.E., Jr. 1970. Floret development, embryology, and systematic position of *Oryzopsis hendersonii* (Gramineae). Canad. J. Bot. 48:1741–1759.

MEYEROWITZ, E.M. 2002. Plants compared with animals: the broadest comparative study of development. Science 295:1482–1485.

MÜLLER, G.B. AND S.A. NEWMAN. 2005a. Editorial: evolutionary innovation and morphological novelty. J. Exp. Zool. (Molec. Dev. Evol.) 304B:485–486.

MÜLLER, G.B. AND S.A. NEWMAN. 2005b. The innovation triad: an evodevo agenda. J. Exp. Zool. (Molec. Dev. Evol.) 304B:487–503.

MURBACH L. 1900. Note on the mechanics of seed burying awns of Stipa aveneca. Bot. Gaz. 30:113–117.

OLSON, M.E. 2003. Ontogenetic origins of floral bilateral symmetry in Moringaceae (Brassicales). Amer. J. Bot. 90:49–71.

PIGLIUCCI, M. 2007. Do we need an extended evolutionary synthesis? Evolution 61:2743–2749.

PIGLIUCCI, M. AND C.J. MURREN. 2003. Perspective: genetic assimilation and a possible evolutionary paradox: can macroevolution sometimes be so fast as to pass by? Evolution 57:1455–1464.

PRAY, L.A. 2004. Epigenetics: genome meet your environment. Scientist 18:14–24.

RICHARDS, J.H, J.J. BRUHL, AND KL WILSON. 2006. Flower or spikelet? Understanding the morphology and development of reproductive structures in Exocarya (Cyperaceae, Mapanioideae, Chrysitricheae). Amer. J. Bot. 93:1241–1250.

ROBSON, K.A, J. MAZE, S. BANERJEE, AND R.K. SCAGEL. 1993. Ontogeny, phylogeny and intraspecific variation in North American Abies Mill. Pinaceae: an empirical approach to organization and evolution. Taxon 42:17–34.

ROLLAND-LAGAN, A-G, E. COEN, S.J. IMPEY, AND J.A. BANGHAM. 2005. A computational method for inferring growth parameters and shape changes during development based on clonal analysis. J. Theor. Biol 232:157–177.

SMITH, R.S., S. GUYOMARC'H, T. MANDEL, D. REINHARDT, C. KUHLEMEIR, AND P. PRUSINKIEWICZ. 2006. A plausible model of phyllotaxis. Proc. Nat. Acad. Sci. 103:1301–1306.

SOLTIS, D.E., P.S. SOLTIS, M.W. CHASE, M.E. MORT, D.C. ALBACH, M. ZANIS, V. SAVOLAINEN, W. JAHN, S.B. HOOT, M.F. FAY, M. AXTELL, S.M. SWENSEN, L.M. PRINCE, W.J. KRESS, K.C. NIXON, AND J.S. FARRIS. 2000. Angiosperm phylogeny inferred from 18S rDNA, rbcL, and atpB sequences. Bot. J. Linn. Soc. 133:381–461.

SPELLENBERG, R.W. AND L.E. MEHLENBACHER. 1971. Anatomical and cytological studies of an intergeneric hybrid *Oryzopsis hendersonii* and *Stipa lemmonii* (Gramineae). Canad. J. Bot. 49:1565–1574.

STEBBINS, G.L. 1967. Gene action, mitotic frequency, and morphogenesis in higher plants. In: M Locke ed. Control mechanisms in developmental processes. 26th Symposium, The Society for Developmental Biology. Academic Press, London. (= Supplement 1, Developmental Biology). Pp. 113–135.

STEELE, E.J., R.A. LINDLEY, AND R.V. BLANDEN. 1998. Lamarck's signature. Perseus Books, Reading MS.

TEPFER, S. 1953. Floral anatomy and ontogeny in *Aquilegia formosa* v. *truncata* and *Ranunculus repens*. Univ. Calif. Publ. Bot. 25:513–648.

TUCKER, S.C. 1959. Ontogeny of the inflorescence and flower in *Drimys winteri* var. *chilensis*. Univ. Calif. Publ.Bot. 30:257–336.

WADDINGTON, C.H. 1953 Epigenetics and evolution. In: R Brown and JF Danielli, eds. Evolution (SEB Symposium VII). Cambridge Univ. Press, Cambridge. Pp. 186–199.

WEST-EBERHAND, J. 2005. Phenotypic accommodation: adaptive innovation due to phenotypic plasticity. J. Exp. Zool. (Molec. Dev. Evol.) 304B:610–618.

WILKINSON, L. 1991. SYSTAT: the system for statistics. Evanston, IL.

THOMAS WALTER'S SPECIES OF *HEDYSARUM* (LEGUMINOSAE)

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ABSTRACT

Thomas Walter, author of *Flora Caroliniana* (1788), treated twelve species as members of the genus *Hedysarum* (Leguminosae). With one exception, his names have been overlooked in monographic and floristic studies. Walter's names are here associated with the modern species they represent, within the genera *Desmodium* and *Lespedeza*.

KEY WORDS: Thomas Walter, *Flora Caroliniana*, Leguminosae, *Hedysarum*, *Desmodium*, *Lespedeza*

RESUMEN

Thomas Walter, el author de *Flora Caroliniana*, examinó doce species como miembros del género *Hedysarum* (Leguminosae). Con una excepción, sus nombres se han pasado por alto en estudios monográficos y florísticos. Los nombres de Walter están aquí asociados con las especies modernas que representan, dentro de los géneros *Desmodium* y *Lespedeza*.

Thomas Walter, pioneer botanist and rice-plantation owner on the Santee River, Berkeley County, South Carolina, recognized 1056 species in his *Flora Caroliniana* (1788), the first treatment of American plants to use the Linnaean sexual system of classification and binomial nomenclature. Of these, over 400 were of species he believed to be new, while others were taken from the works of Carl Linnaeus. Many of Walter's names are in common use today and are readily recognized in American floras by the author designation "Walt." But an appreciable number of his names were described so briefly (in Latin) or without clear distinction from other species that later authors have been unable to interpret his meaning, either to acknowledge his names as new or to assign them to appropriate synonymic status.

No index has yet been prepared that fully identifies Walter's names. Later authors have from time to time dipped into his *Flora* and determined as best they could the meaning of the names he gave to members of a given genus or family. Most importantly, Hitchcock (1905) has surveyed the grasses, Dayton (1952) the pines, Wilbur (2002) the oaks, and Ward (2010) the plants referred to by Walter as *Melanthium* (Liliaceae). The present task is to puzzle out the twelve species Walter assigned to the genus *Hedysarum* (Leguminosae).

Hedysarum L. is not a generic name familiar to botanists of the American Southeast. It was used by Linnaeus (1753, 1759, 1762) as a sizable assembly of vaguely related legumes, long since divided into smaller, more discrete generic groupings. *Hedysarum s.s.* is still recognized as a genus of about 100 north temperate species (Mabberley 1997: 331), none of which occur south of Maine or Vermont. The segregate known as *Desmodium* Desv. is a rather large, mostly herbaceous genus with peculiar jointed uncinate fruits, while *Lespedeza* Michx. is a distinct genus of herbs or sub-shrubs with indehiscent one-seeded fruits and pinnate trifoliolate leaves.

Because of their commercial importance, the legumes have received thorough taxonomic examination. Two surveys of the family are of note: the meticulously described legumes of North Carolina (Wilbur 1963), and the comprehensive understanding of the southeastern U.S. legumes (Isely 1990).

Eastern species of *Desmodium* fall into two sections: a group of three species with peculiar long-stipitate fruits well monographed (with their Asian allies) by Isely (1951), and a larger group of species best understood by Schubert (1950) and supplemented by Isely (1983). American species of *Lespedeza* have been carefully studied by Clewell (1966). Indicative of the neglect vested upon many Walter names, none of these authors has addressed those species of interest hidden in Walter's *Hedysarum*.

Association of the names of *Hedysarum* used by Walter with the names recognized by modern botanists

J. Bot. Res. Inst. Texas 4(2): 705 – 710. 2010

is not straightforward. Unlike in *Quercus*, where Wilbur (2002) was equating the dozen Walter names with a modern-day Berkeley County species-list of near-equal numbers, Walter's *Hedysarum*, consisting of both *Desmodium* and *Lespedeza*, is more lengthy and uncertain. Walter recognized twelve species of *Hedysarum*. The county-record maps prepared by Wilbur (in Radford et al. 1968) indicate nineteen species of *Desmodium* and twelve species of *Lespedeza* to be expected on the Carolina coastal plain, with still others found not far beyond. Thus, fewer than half of the species that Walter possibly might have known can be represented in his *Flora*.

It is conceivable that the range of species available to Walter was appreciably greater than those found in the modern coastal plain flora. Though Walter, in the introduction to his *Flora*, stated he had made his observations within a 50-mile radius of his Santee River plantation, it has long been recognized that John Fraser, who in 1787 traveled into the Appalachians and as far south as central Georgia, provided Walter with materials of otherwise unknown species. Certainly, the Fraser Fir (*Abies fraseri*, Walter's "*Pinus Cedrus*"), the Showy Ladyslipper (*Cypripedium reginae*), and other distinctive species could only have come to Walter via Fraser. The role of Fraser as a source of Walter's materials should not be overemphasized, however. For commonplace-appearing species that also occur in abundance on the coastal plain, there is little logic in Fraser having gathered plants unappealing for horticulture, nor Walter in choosing them for description over materials available near his home.

Little information is available from herbarium materials. Walter himself kept no herbarium (Ward 2007a). Fraser's abundant collections were briefly available to Walter, who annotated many of the often-fragmentary specimens (Ward 2006). These specimens (the Fraser/Walter folio herbarium, Natural History Museum, London) at times give a clue to the species Walter had described in his *Flora*, though too often Fraser's specimen (perhaps collected in the Carolina mountains) is not the same as the plant intended by Walter (from near his home on the Carolina coastal plain).

Five specimens of the genus *Hedysarum* were mounted on a single page (p. 55) of the Fraser/Walter folio herbarium (either by Fraser himself or his sons), following Fraser's return to London in early 1788. All have now been given page-number/specimen-letter designations (Ward 2006). All five bear three-digit numbers identified as Fraser's field numbers, and all five have labels with handwriting identified as Walter's. These specimens, with Fraser's number, Walter's label, and its modern identification, are: (1) 55-B: "228"; "Hedysarum violaceum"; *Lespedeza repens* (L.) Barton. (2) 55-C: "500"; "Hedysarum Flore magnus"; *Desmodium cuspidatum* (Muhl. ex Willd.) Loudon. (3) 55-D: "457"; "Hedysarum"; (crumpled, unidentified). (4) 55-E: "615"; "Hedysarum"; probably *Lespedeza virginica* (L.) Britt. (5) 55-F: "721"; "Hedysarum"; *Lespedeza capitata* Michx. Only one of these specimens, that of *D. cuspidatum* (55-C), has been identified as corresponding to one of Walter's species of *Hedysarum* (Fernald and Schubert 1948). A second specimen, that of *L. repens* (55-B), bears an epithet used by Walter although his description more closely matches *D. lineatum* DC. True *L. repens*, a common Carolina species, does appear to have been known by Walter, but was misnamed by him as *H. violaceum* [= *L. violacea* (L.) Pers.].

Thus, identification of Walter's names must be based upon little more than the brief Latin phrase (often taken from Linnaeus) he used for description, and an estimate of the probability that Walter would have encountered the plant near his home. Where two species are of similar frequency, yet also similar in appearance and thus likely not distinguished by him, no single-species identification is possible. Where a species is common and thus surely known to Walter, the assumption is made that it *must* be found among his described species. Rare species are mostly disregarded; only where a species may be rare but with a distinctive feature seemingly described by Walter, is its rarity as an excluding trait set aside.

The following identifications are not set in stone. Thoughtful consideration of the available data and the conditions under which Walter worked may cause others to see connections that have been misunderstood here. Yet even the conclusions drawn here, imperfect as they may be, may have value in giving tentative meaning to scientific names that for too long have remained obscure.

The species Walter recognized in the genus *Hedysarum* are listed below, in the sequence as originally

published. An occasional word or phrase italicized and thus emphasized in Walter's descriptions is shown here in Roman. Abundance within South Carolina is largely inferred from the county-record maps prepared by Radford et al. (1968). A measure of the likelihood of correct identification is attempted by uniform usage of modifying adverbs preceding the name, where a simple assertion means "little room for doubt," and "probably" and "possibly" indicate increasing levels of uncertainty.

LIST OF SPECIES

WALTER'S NAME: *Hedysarum junceum* (p. 184). Linnaeus, Sp. Pl. ed. 2. 1053. 1762; misapplied.
WALTER'S DESCRIPTION: foliis ternatis lanceolatis, leguminibus uniarticulatis, pedunculis lateralibus subumbelliferis.
MODERN NAME: **Desmodium strictum** (Pursh) DC., or **Desmodium tenuifolium** Torr. & A. Gray
COMMENTS: Both *Desmodium strictum* and *D. tenuifolium* are frequent in eastern South Carolina. Walter's description is taken directly from Linnaeus, only contracted slightly by deletion of Linnaeus' "*rhombeis*" following "*uniarticulatis*." Not *Lespedeza juncea* (L.) Pers., of Asia. The often single-loment fruits and lanceolate leaflets are distinctive of *D. strictum* and *D. tenuifolium*, though the description is inadequate to determine which. No specimen of either of these species is present in the Fraser/Walter herbarium (BM).

The herbarium does hold a specimen collected by Fraser (55-A), labeled "*an Hedysarum*" by Walter and annotated "*Hedysarum junceum* Walt." by A. M. Vail. It appears to be *Psoralea pedunculata* (Mill.) Vail [= *P. psoralioides* (Walt.) Cory]. But since Walter clearly intended *P. psoralioides* to be represented by his "*Trifolium psoralioides*" (p. 184), there is no reason to believe the Fraser specimen is also his "*Hedysarum junceum*."

WALTER'S NAME: *Hedysarum umbellatum* (p. 184). Linnaeus, Sp. Pl. 747. 1753; misapplied.
WALTER'S DESCRIPTION: fol. ternatis pedunculis umbelliferis, caule fruticoso recto.
MODERN NAME: Probably **Desmodium glutinosum** (Muhl. ex Willd.) Wood
COMMENTS: Infrequent in eastern South Carolina. Walter's description was taken directly from Linnaeus, with only "*recto*" (erect) added. Not *Hedysarum umbellatum* L., of India. The "*umbelliferis*" foliage seems unique to the false whorls of *D. glutinosum*; leaves of the related *D. pauciflorum* (Nutt.) DC. are spaced along the stem. No specimen is present in the Fraser/Walter herbarium.

WALTER'S NAME: *Hedysarum barbatum* (p. 184). Linnaeus, Syst. Nat. ed. 10. 2:1170. 1759; misapplied.
WALTER'S DESCRIPTION: *fol. ternatis, floribus racemosis cernuis, calycibus pilosis, leguminibus biarticulatis.*
MODERN NAME: **Desmodium ciliare** (Muhl. ex Willd.) DC.
COMMENTS: Frequent throughout. Walter's "*biarticulatis*" loments and "*pilosis*" calyces well fit this species. [This identification appears first to have been made by Woods (2008).] Not *Desmodium barbatum* (L.) Benth., of the American tropics. Walter's description was taken directly from Linnaeus, only slightly reordered. Articulated fruit confirms that this is a *Desmodium*. *Desmodium fernaldii* Schub., *D. glabellum* (Michx.) DC., and *D. perplexum* Schub., a complex of poorly defined species frequent in eastern South Carolina, were also considered; but were rejected (fruits often have more than two segments, calyces are scarcely pubescent). *Desmodium strictum* (Pursh) DC. and *D. tenuifolium* Torr. & A. Gray usually have one or two segments, but appear best assigned under Walter's "*Hedysarum junceum*." No specimen is present in the Fraser/Walter herbarium.

WALTER'S NAME: *Hedysarum marilandicum ?* (p. 185). Linnaeus, Sp. Pl. 748. 1753.
WALTER'S DESCRIPTION: *fol. ternatis: foliolis* ovatis *laevibus, caule ramoso* vix fruticoso, *leguminibus articulatis laevibus.*
MODERN NAME: Probably **Desmodium laevigatum** (Nutt.) DC.
COMMENTS: Infrequent in eastern South Carolina, more common westward. Description is modified from Linnaeus (*foliis ternatis: foliolis subrotundis, caule frutescente ramosissimo, leguminibus articulatis laevibus*). The articulated fruits confirm this to be a *Desmodium*, although no Carolina fruits of that genus are truly smooth

("*laevibus*"). Leaflets of *Desmodium laevigatum* are ovate and glabrous, and the loments are finely pubescent only along the sutures, otherwise smooth. *Desmodium marilandicum* (L.) DC. has smooth ovate leaflets ("*ovatis*" emphasized by Walter), though its fruits are "uncinulate-puberulent" (Wilbur 1963), not smooth, and it is quite rare on the South Carolina coastal plain. No specimen is present in the Fraser/Walter herbarium.

Walter's name: *Hedysarum frutescens ?* (p. 185). Linnaeus, Sp. Pl. 748. 1753; misapplied.
Walter's description: *fol. ternatis: foliolis subrotundis, subtus villosioribus, caule ramoso*, vix fruticoso.
Modern name: Probably **Lespedeza stuevei** Nutt.
Comments: Common throughout. Description is largely original (Linnaeus: *foliis ternatis subovatis, caule frutescente*). *Lespedeza stuevei* fits well in that leaflets are ovate to suborbicular and densely pubescent beneath; it is also "scarcely" fruticose. The name is misapplied; true *L. frutescens* (L.) Britt. [= *Hedysarum frutescens* L.; *Lespedeza intermedia* (Wats.) Britt.] is more delicate, less pubescent, and less common (Clewell 1966). No specimen has been identified in the Fraser/Walter herbarium. [Specimen 55-F appears to be the closely related *Lespedeza capitata* Michx.; its label bears only "*Hedysarum*" in Walter's hand and "721" in Fraser's.]

Walter's name: *Hedysarum grandiflorum* Walter (p. 185)
Walter's description: *fol. ternatis ovalibus* venosis utrique laevibus; *racemis axillaribus erectis, leguminibus pendulis multiarticulatis, floribus majoribus.*
Modern name: **Desmodium cuspidatum** (Muhl. ex Willd.) Loud.
Comments: Infrequent throughout South Carolina. Not *Hedysarum grandiflorum* Pallas (1773); Walter's name is a later homonym and thus illegitimate. Fernald and Schubert (1948: 203) identified specimen 55-C of the Fraser/Walter herbarium as *H. grandiflorum* Walt. and referred to it as "Walter's TYPE." The specimen was labeled "*Hedysarum Flore magnus*" by Walter, who seems not to have recognized it as his own "*Hedysarum grandiflorum*," as named in his *Flora*. Having been noted by Fernald and Schubert, their typification has been corrected to neotype for *H. grandiflorum* Walt. (Ward 2007b).

Walter's name: *Hedysarum viridiflorum* (p. 185). Linnaeus, Sp. Pl. 748. 1753.
Walter's description: *fol. ternatis acutiusculis, caule suberecto, paniculis longis erectis.*
Modern name: Probably **Desmodium viridiflorum** (L.) DC.
Comments: Infrequent in eastern South Carolina, common westward. Walter's description is modified from Linnaeus (*foliis ternatis acutiusculis, caule erecto, racemis longissimis erectis*). The "*acutiusculis*" (slightly acute) leaves describes *Desmodium viridiflorum*, but is scarcely unique. No specimen is present.

Walter's name: *Hedysarum hirtum* (p. 185). Linnaeus, Sp. Pl. 748. 1753.
Walter's description: *fol. ternatis ovalibus, caule fruticoso, racemis ovatis, calycibus fructibusque hirsutis monospermis.*
Modern name: Probably **Lespedeza hirta** (L.) Hornem.
Comments: Frequent throughout. Description is largely original (Linnaeus: *foliis ternatis ovatis, floribus geminatis, leguminibus nudis venosis monospermis*). Walter's description has no point of conflict with *L. hirta*; its fruits are densely pubescent. *Desmodium ciliare* (Muhl. ex Willd.) DC. was also considered; its fruits are often single-seeded and its calyces pubescent (but scarcely hirsute). If that species, Walter's epithet has priority over that of Muhlenberg ex Willdenow (1803). No specimen is present.

Walter's name: *Hedysarum violaceum* (p. 185). Linnaeus, Sp. Pl. 749. 1753; misapplied.
Walter's description: *fol. ternatis ovatis, floribus geminatis, leguminibus nudis venosis monospermis, caule flexuoso.*
Modern name: Probably **Lespedeza repens** (L.) Barton
Comments: Common throughout. Walter's description is taken directly from Linnaeus, with only "*caule flexuoso*" added. This fits *Lespedeza repens* rather well (flowers are solitary or in 2s or 3s; fruits are "*venosis*" (conspicuously veined), single-seeded; but stem is scarcely flexuous. The name is misapplied (Reveal and

Barrie 1991); *Lespedeza violacea* (L.) Pers. (= *Hedysarum frutescens*, misapplied) is very rare in South Carolina (one county). Specimen 55-B was labeled "*Hedysarum violaceum*" by Walter; it is surely *L. repens*.

WALTER'S NAME: *Hedysarum repens* (p. 185). Linnaeus, Sp. Pl. 749. 1753; misapplied.
WALTER'S DESCRIPTION: *fol. ternatis obcordatis, caule procumbente, racemis lateralibus.*
MODERN NAME: Possibly **Desmodium lineatum** DC.
COMMENTS: If this species, infrequent in eastern South Carolina. This seems the only procumbent *Lespedeza* or *Desmodium* with leaflets broad enough (often obovate) to be considered "*obcordatis*." *Lespedeza repens* was also considered; it is common throughout, racemes are axillary and stems procumbent, but leaflets are mostly elliptic, and it had also been suggested as Walter's *Hedysarum violaceum*. No specimen is present.

WALTER'S NAME: *Hedysarum paniculatum* (p. 185). Linnaeus, Sp. Pl. 749. 1753.
WALTER'S DESCRIPTION: *fol. ternatis lineari-lanceolatis, floribus paniculatis, caule erecto.*
MODERN NAME: **Desmodium paniculatum** (L.) DC.
COMMENTS: Frequent throughout. Walter's description is taken directly from Linnaeus, with "*caule erecto*" added. Linear-lanceolate leaflets fit this species, as do erect much-branched ("*paniculatis*") inflorescences. No specimen is present.

WALTER'S NAME: *Hedysarum nudiflorum* (p. 185). Linnaeus, Sp. Pl. 749. 1753.
WALTER'S DESCRIPTION: *fol. ternatis, scapo florifero aphyllo paniculato.*
MODERN NAME: **Desmodium nudiflorum** (L.) DC.
COMMENTS: Frequent throughout. Description is modified (Linnaeus: *foliis ternatis, scapo florifero nudo, caule folioso angulato*). The long naked scape of *D. nudiflorum* is diagnostic. No specimen is present.

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REFERENCES

CLEWELL, A.F. 1966. Native North American species of *Lespedeza* (Leguminosae). Rhodora 68:359–405.
DAYTON, W.A. 1952. Some notes on United States tree names. Rhodora 54:67–79.
FERNALD, M.L. AND B.G. SCHUBERT. 1948. Studies of American types in British herbaria. Part IV: some species of Thomas Walter. Rhodora 50:190–208, 217–229.
HITCHCOCK, A.S. 1905. The identification of Walter's grasses. Rep. (Annual) Missouri Bot. Gard. 16:31–56.
ISELY, D. 1951. *Desmodium*: section *Podocarpium* Benth. Brittonia 7:185–224.
ISELY, D. 1983. The *Desmodium paniculatum* complex revisited. Sida 10:142–158.
ISELY, D. 1990. Vascular flora of the southeastern United States, vol. 3. pt. 2: Leguminosae (Fabaceae).
LINNAEUS, C. 1753. Species plantarum. Stockholm.
LINNAEUS, C. 1759. Systema naturae. Stockholm.
LINNAEUS, C. 1762. Species plantarum, ed. 2. Stockholm.
MABBERLEY, D.J. 1997. The plant-book. Cambridge University Press, Cambridge.
RADFORD, A.E., H.E. AHLES, AND C.R. BELL. 1968. Manual of the vascular flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill.
REVEAL, J.L. AND F.R. BARRIE. 1991. On the identity of *Hedysarum violaceum* Linnaeus (Fabaceae). Phytologia 71:456–461.
SCHUBERT, B.G. 1950. *Desmodium*: preliminary studies - III. Rhodora 52:135–155.
WALTER, T. 1788. Flora Caroliniana. London.

Ward, D.B. 2006. Thomas Walter typification project, I: observations on the John Fraser folio. Sida 22: 1111–1118.

Ward, D.B. 2007a. The Thomas Walter herbarium is not the herbarium of Thomas Walter. Taxon 56:917–926.

Ward, D.B. 2007b. Thomas Walter typification project, II: the known Walter types. J. Bot. Res. Inst. Texas 1: 407–423.

Ward, D.B. 2010. Thomas Walter's species of *Melanthium* (Liliaceae). J. Bot. Res. Inst. Texas 4:305–309.

Wilbur, R.L. 1963. The Leguminous plants of North Carolina. North Carolina Agric. Exp. Sta., Durham.

Wilbur, R.L. 2002. Thomas Walter's oaks from the coastal region of South Carolina. Rhodora 104:134–150.

Woods, M. 2008. The genera *Desmodium* and *Hylodesmum* (Fabaceae) in Alabama. Castanea 73:46–69.

LISTADO FLORÍSTICO Y ASPECTOS ECOLÓGICOS DE LA FAMILIA POACEAE PARA CHIHUAHUA, DURANGO Y ZACATECAS, MÉXICO

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RESUMEN

Se presenta un listado florístico de las Poaceae en tres estados del norte-centro de México (Chihuahua, Durango y Zacatecas), resultado de investigaciones que se desarrollan en el herbario CIIDIR (IPN Durango), que nos permitió analizar algunos aspectos de la riqueza de dicha familia en la región. La riqueza florística de la familia Poaceae en México está dada por su posición en el área de contacto de las regiones Holártica y Neotropical, así como por su topografía, clima y geología variables. De los 204 géneros y 1,182 especies reportados para México, 117 géneros (57%) y 505 especies (43%) se distribuyen en esta región del norte del país. Se llevó a cabo un análisis de la distribución espacial de las especies y de algunos aspectos ecológicos que la afectan. El análisis de la distribución por preferencias de hábitat señala que 33.5% de las especies se encuentran en bosque templado, 28.4% en pastizal, 23.6% en matorral xerófilo y 14.5% en bosque tropical; por su origen se encuentra que 70% de las especies son nativas de América, 20% son endémicas de México y 10% son exóticas. La distribución de las subfamilias responde claramente a sus afinidades; así las Chloridoideae y Aristidoideae de ambientes tropicales y subtropicales mas áridos, son las mejor representadas en esta región (42% y 5% respectivamente), le siguen en importancia las Panicoideae de ambientes tropicales y distribución austral (28%), y las Pooideae de ambientes templados y distribución boreal (22%). Se discuten estos resultados y otros pequeños grupos con requerimientos de sustrato particulares.

PALABRAS CLAVE: Listado florístico, Poaceae, gramíneas, norte de México

ABSTRACT

We present a floristic checklist of the Poaceae in three north-central states of Mexico (Chihuahua, Durango and Zacatecas), results of investigations being carried out in the herbarium CIIDIR of IPN Durango, which allowed us to analyze some aspects of the richness of this family in the region. The floristic richness of the family Poaceae in Mexico is given by its geographical position in the contact area of the Holarctic and Neotropical regions, and for its rugged topography, climate and geology variables. Of the approximately 204 genera and 1182 species reported for Mexico, 117 genera (57%) and 505 species (43%) are distributed in this region of northern Mexico. We carried out an analysis of spatial distribution of the species and some ecological aspects that affects them. Habitat preferences indicate that 33.5% of the species found in temperate forest, 28.4% in grassland, 23.6% in desert scrub and 14.5 % in tropical deciduous forest; for its origin, it is found that 70% of the species are native to America, 20% are endemic to Mexico and 10% are exotic. The distribution of the subfamilies clearly response to their affinities, thus the Chloridoideae and Aristidoideae from tropical and subtropical more arid environments are the best represented in this region (42% and 5% respectively), followed in importance by the Panicoideae from tropical environments and austral distribution (28%), and the Pooideae from temperate environments and boreal distribution (22%). Results are discussed and other small groups with special substrate requirements.

KEY WORDS: Floristic checklist, Poaceae, grasses, north of México

INTRODUCCIÓN

Las gramíneas en cuanto a riqueza de especies es la cuarta familia de plantas vasculares, después de las compuestas, las leguminosas y las orquídeas, y la más distribuida en el mundo. Se le encuentra desde los círculos polares hasta el ecuador, en las cumbres de las montañas y al nivel del mar (Lawrence 1951). En México ocupan el tercer lugar superando en número de especies a las orquídeas (Rzedowski 1978).

No obstante, parecen ocupar el primer lugar en cuanto a su importancia económica, ya que pertenecen a esta familia los cereales como el arroz, trigo, maíz y caña de azúcar, base de la alimentación humana. La avena, el centeno, el sorgo y el bambú, también de gran importancia para los humanos por proveer de materia prima para forraje en la producción de ganado. Así también el bambú ha sido utilizado ampliamente (desde

las antiguas civilizaciones orientales) para la construcción de casas y muebles, elaboración de artesanías y otros productos. En México las especies que son utilizadas regionalmente en la elaboración de enseres domésticos y artesanías como canastos, escobas y adornos, así como especies ornamentales de jardines se reportan por Mejía-Saulés y Dávila (1992).

Se estima que existen alrededor de 700 géneros y 10,000 especies de gramíneas en el mundo (Clayton & Renvoize 1986), de ellos 204 géneros y 1,182 especies se encuentran en México (Dávila y col. 2006). 117 géneros (57%) y 505 especies (43%) se distribuyen en esta región del norte del país. Chihuahua cuenta con 98 géneros y 383 especies encontrados y registrados a la facha (Herrera y Peterson 2007; Herrera y Cortés en proceso), mientras que Durango cuenta con 97 géneros y 368 especies (Herrera 2001; Herrera y Pámanes 2006 y Herrera, en revisión), y Zacatecas con 91 géneros y 284 especies según el más reciente recuento (Herrera y col. 2010). Es la familia de plantas con mayor importancia ecológica por su diversidad, por su característica capacidad de formar suelos y porque la mayoría de sus especies son elementos naturales de vegetaciones primarias, aun cuando un porcentaje no muy alto de ellas (5 a 8% estimado) han desarrollado la capacidad de dispersarse por el mundo y establecerse como adventicias en hábitats diversos.

Por la importancia que reviste la familia Poaceae, el trabajo nomenclatural ha sido cuantioso y elaborado, así la primicia en la revisión de las gramíneas de América ha sido llevada a cabo por agrostólogos del Instituto Smithsoniano, quienes además de realizar colectas en todo el continente desde finales del Siglo XIX, de verificar la identidad de los taxa, de describir y aplicar nombres a nuevas especies, para finalmente editar la información obtenida en importantes obras florísticas y florístico-ecológicas de extensas regiones como Norteamérica (Hitchcock & Chase 1951), de regiones más localizadas como "La Nueva Galicia" (McVaugh 1983) o "Los pastizales de Durango" (Gentry 1957). Así, se inicia el registro en Catálogos, de los nombres que recibieron los pastos de este continente, a partir de las expediciones de colectores europeos en la Nueva España. Se encuentra que un gran número de taxa recibió para sí solos varios nombres en diferentes tiempos por diversos autores, mientras que algunos nombres (escasos) fueron aplicados de forma repetida a plantas diferentes. Ambos casos tuvieron que ser reconocidos como sinónimos del nombre con mayor antigüedad de registro para cada taxón. Quizá el primer catálogo relevante de gramíneas para nuestro continente sea el "Índice de gramíneas de América" editado por Chase y Niles (1962), quienes incluyeron los nombres aceptados y sinonimia reconocida para su tiempo.

Las Poaceae presentan una distribución ecológica amplia, aún cuando son los componentes principales de los pastizales, se encuentran en el sotobosque de los bosques y matorrales de la Sierra Madre Occidental de Chihuahua, Durango y parte de Zacatecas (Fig. 1). Hay algunas especies que se encuentran desde el bosque hasta el pastizal, otras en los matorrales y el pastizal, mientras que otras son específicas de condiciones ecológicas particulares. Así, las especies presentan una distribución mayormente altitudinal, mientras que un grupo pequeño requiere de un sustrato específico para sobrevivir. Ejemplo de esto son las especies de suelos con altas concentraciones de sales y las especies acuáticas y subacuáticas.

Durante la realización de proyectos financiados por la CONABIO, se generó una base de datos con aproximadamente 8000 registros de poáceas colectadas en los estados de Chihuahua, Durango y Zacatecas, provenientes de la revisión y registro de datos tomados de ejemplares de herbario, de colectas realizadas por diversos colectores durante los últimos 120 años y depositados en diferentes herbarios del país y del extranjero, mismos que fueron registrados en el sistema Biótica proporcionado por la CONABIO. Los sitios de colecta georreferenciados señalan datos interesantes de las preferencias ecológicas, distribución geográfica y riqueza de los 117 géneros y 505 especies presentes en esta región. Esta lista florística tiene como propósito fundamental contribuir al conocimiento de la flora de la familia Poaceae del norte-centro de México.

MATERIALES Y MÉTODOS

Se revisaron aproximadamente 8000 ejemplares de herbario, entre ellos algunos 500 ejemplares colectados, por el primer autor. La revisión de los especimenes consistió en: 1) validar la identidad taxonómica, 2) actualizar los nombres en sinonimia, 3) modificar y/o adecuar las determinaciones erróneas, y 4) identificar

FIG. 1. Mapa de ubicación, municipios y sitios de colecta en los estados de Chihuahua, Durango y Zacatecas, México.

los taxa no determinados; tomando como base las descripciones de la bibliografía citada en los géneros y especies. Los herbarios revisados en México por la primera autora son: CHAPA, CIIDIR, ENCB, HUAZ, IEB, MEXU y SLPM, y en Estados Unidos: TAES y US. Se realizó el análisis de frecuencias a partir de los datos contenidos en el "Listado florístico de gramíneas de Chihuahua, Durango y Zacatecas, México" (Tabla 1).

La determinación de la identidad de las especies en los ejemplares revisados se llevó a cabo utilizando claves y descripciones de diversas obras florísticas para Norteamérica (Hitchcock & Chase 1951), para Mesoamérica (Davidse y col. 1994), y algunas regiones de México (McVaugh 1983; Herrera 2001; Herrera y Pámanes 2006; Herrera y col. 2010).

La actualización de la nomenclatura se realizó con base en dos Catálogos: 1) Catálogo de Gramíneas del Nuevo Mundo (Judziewicz y col. 2000; Peterson y col. 2001; Zuloaga y col. 2003 y Soreng y col. 2003), editado por J.R. Soreng del Instituto Smithsoniano, catálogo que se encuentra en revisión y actualización permanente pudiendo ser consultado vía internet en: (http://mobot.mobot.org/W3T/Search/nwcg.html), 2) Catálogo de las Gramíneas de México, (Dávila y col. 2006); donde se reportan nombres reconocidos y sinonimia para los taxa mexicanos. Además ha sido enriquecida con publicaciones muy recientes de cambios en la nomenclatura de algunos taxa (ejemplo Finot y col. 2004; Bess y col. 2006; Zuloaga y col. 2007; Bell y Columbus 2008; Valdés-Reyna y col. 2009) y/o adiciones de nuevas especies encontradas (ejemplo Finot y col. 2004; Peterson y col. 2004; Peterson y col. 2006, Peterson y Columbus 2009), así como la revisión permanente de ejemplares colectados en estos tres Estados.

RESULTADOS

En el Anexo 1 se encuentran relacionados los 536 taxa: géneros, especies, subespecies, variedades y formas, de la región norte-centro de México. En ella se relacionan las comunidades vegetales donde se distribuye cada taxón, el posible origen, la subfamilia a la que pertenecen y por último el estado (Chihuahua, Durango o Zacatecas) de donde provienen especímenes de referencia, (escasos son los casos que se citan sin ejemplar revisado).

Algunos resultados del análisis de frecuencias se sintetizan en los gráficos que se presentan en el presente reporte.

El porcentaje de especies encontradas en cada uno de los estados de la región norte-centro de México se relacionan en la gráfica de la Figura 2.

Distribución y Riqueza de especies.

En la región norte-centro de México los cuatro ecosistemas vegetales principales son:

- Bosques templados (encinos, coníferas)
- Selvas bajas o bosques tropicales
- Pastizales
- Matorrales xerófilos (rosetófilo, espinoso y micrófilo)

De estas comunidades la riqueza de zacates se concentra en los bosques templados y pastizales, que son los que presentan condiciones medias de temperatura, humedad y altitud (Fig. 3).

Las poaceas presentan una distribución ecológica amplia ya que aunque son los componentes principales de pastizales, se encuentran numerosas especies en el sotobosque de las áreas boscosas de la región, así como en los diversos tipos de matorrales.

Bosques Templados

Están representados por los bosques de pino, de encino, o mixtos (*Pinus, Quercus, Abies, Pseudotsuga, Cupressus* y *Juniperus*). Se distribuyen en la parte alta de la Sierra Madre Occidental, en elevaciones que van desde 2100 a 3250 m s.n.m. En ellos se encuentra la mayor riqueza florística de gramíneas de la región.

Selva Baja o Bosque Tropical Caducifolio

Esta comunidad vegetal se distribuye en la zona de cañones y cañadas, y es conocida regionalmente como

Tabla 1. Listado florístico de las gramíneas de Chihuahua, Durango y Zacatecas, México.

Especie	Comunidades vegetales					Origen						
	Bosque	Selva	Matorral	Pastizal	Otros	Nativa	End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
Achnatherum curvifolium				x		Na			Pha			x
Achnatherum editorum	x		x	x		M	M		Pha		x	
Achnatherum eminens	x	x	x	x		Na			Pha	x	x	x
Achnatherum hymenoides			MDM		dunas	Na			Pha			x
Achnatherum multinode	x					M	M		Pha		x	x
Achnatherum robustum	x			x		Na			Pha			x
Aegopogon cenchroides	x					Sa			Chl	x	x	x
Aegopogon tenellus	x			x		Na			Chl	x	x	x
Agropyron cristatus	x			x		A			Poo			x
Agrostis exarata	x					Na			Poo	x		x
Agrostis hyemalis	x					A			Poo	x	x	x
Agrostis liebmannii	x					M	M		Poo	x		
Agrostis perennans	x					A			Poo	x		
Agrostis rosei	x					M	D,Z		Poo	x	x	
Agrostis scabra	x					A			Poo	x		x
Agrostis subrepens	x					Sa			Poo			x
Agrostis tolucensis	x					Sa			Poo	x		
Alopecurus geniculatus	x			x		A			Poo			x
Andropogon fastigiatus		x				Sa			Pan		x	
Andropogon gerardii	x					A			Pan	x	x	x
Andropogon glomeratus var. *pumilus*	x					A			Pan	x	x	x
Andropogon pringlei	x		x			M	M		Pan	x	x	
Andropogon virginicus	x					A			Pan	x		
Anthoxanthum odoratum	x					A		x	Poo	x		x
Aristida adscensionis	x		x	x	VR, T	A			Ari	x	x	x
Aristida appressa	x			x		C			Ari	x	x	x
Aristida arizonica	x	x		x		Na			Ari	x	x	x
Aristida curvifolia	x					Na			Ari	x		
Aristida divaricata	x		x	x		Na			Ari	x	x	x
Aristida eludens	x		x	x		M	M		Ari	x		x
Aristida gibbosa		x				Sa			Ari	x		x
Aristida gypsophila f. *diffusa*			x		SY	M	M		Ari		x	

Especie	**Comunidades vegetales** Bosque	Selva	Matorral	Pastizal	Otros	**Origen** Nativa	End-Émica	Exótica	**Sub-familia**	**Dgo.**	**Zac.**	**Chih.**
Aristida. gypsophila f. *gypsophilides*			x		SY	M	M		Ari		x	
Aristida havardii		x	x	x		Na			Ari	x	x	x
Aristida laxa var. *laxa*	x					Sa			Ari	x	x	x
Aristida longespica	x		x	x		Na			Ari		x	
Aristida pansa f. *contracta*			x			Na			Ari		x	
Aristida pansa f. *dissita*			x			Na			Ari	x	x	
Aristida pansa f. *pansa*			x	x		Na			Ari	x	x	x
Aristida purpurea var. *fendleriana*				x		Na			Ari		x	
Aristida purpurea var. *longiseta*			x	x		Na			Ari		x	
Aristida purpurea var. *nealleyi*	x		x	x		Na			Ari	x	x	x
Aristida purpurea var. *perplexa*			MDM			Na			Ari		x	
Aristida purpurea var. *purpurea*	x	x	x			Na			Ari	x	x	x
Aristida purpurea var. *wrightii*			x	x		Na			Ari	x	x	x
Aristida schiedeana var. *orcuttiana*	x	x		x		Na			Ari	x		x
Aristida schiedeana var. *schiedeana*	x	x	x	x		Sa			Ari	x	x	x
Aristida scribneriana	x	x		x		M	M		Ari	x	x	
Aristida spanospicula	x	x				M	Ch,D,Si		Ari	x		x
Aristida ternipes var. *gentilis*			x	x		Na			Ari	x	x	
Aristida ternipes var. *minor*	x			x		Na			Ari	x	x	x
Aristida ternipes var. *ternipes*	x		x	x		A			Ari	x	x	x
Arundinella berteroniana			x	x		Na			Pan			x
Arundinella hispida		x				A			Pan	x		
Arundo donax f. *donax*		x	x		VR, T	A			Aru	x	x	x
Arundo donax f. *versicolor*		x			VR, T	Na			Aru	x	x	
Avena fatua					C	A		x	Poo	x		x
Avena sativa				x	AC,AD	A		x	Poo	x		x
Axonopus mexicanus		x				M	D,Si		Pan	x		
Bealia mexicana	x			x	AC	M	Ch,D,So		Chl	x		x
Blepharidachne bigelovii			MDM			Na			Bam		x	
Blepharoneuron shepherdii	x				AC,AD	M	Ch,D,So		Bam	x	x	x
Blepharoneuron tricholepis	x					Na			Bam	x		x
Bothriochloa alta			x			A			Pan	x	x	x

Tabla 1. continuation

Especie	Comunidades vegetales					Origen			Sub-familia	Dgo.	Zac.	Chih.
	Bosque	Selva	Matorral	Pastizal	Otros	Nativa	End-Émica	Exótica				
Bothriochloa barbinodis	x		x			A			Pan	x	x	x
Bothriochloa hirtifolia	x		x	x		Ca			Pan	x		
Bothriochloa hybrida			x	x		Na			Pan	x		
Bothriochloa ischaemum		x				A		x	Pan	x		
Bothriochloa laguroides var. *torreyana*			x	x		Na			Pan	x	x	
Bothriochloa longipaniculata			x			A			Pan		x	
Bothriochloa palmeri			x	x		Na			Pan	x	x	
Bothriochloa perforata	x		x	x		A			Pan	x	x	x
Bothriochloa saccharoides var. *saccharoides*	x			x		Sa			Pan	x		
Bothriochloa springfieldii	x		x	x		A			Pan	x		x
Bothriochloa wrightii	x		x	x		Na			Pan	x	x	x
Bouteloua aristidoides var. *aristidoides*			x	x	VR,VS	A			Chl	x	x	x
Bouteloua barbata var. *barbata*			x	x		A			Chl	x	x	x
Bouteloua barbata var. *rothrockii*			x	x		Na			Chl		x	
Bouteloua breviseta			x	x		Na			Chl		x	
Bouteloua chasei			MDM		SY	M	M		Chl	x		
Bouteloua chihuahuana			MDM			M	M		Chl		x	
Bouteloua chondrosioides	x		x	x		Na			Chl	x	x	x
Bouteloua curtipendula var. *caespitosa*	x	x	x	x		A			Chl	x	x	x
Bouteloua curtipendula var. *curtipendula*			x	x	BG	Na			Chl	x	x	x
Bouteloua curtipendula var. *tenuis*			x	x		M	M		Chl	x	x	x
Bouteloua dactyloides		x	x	x		Na			Chl	x	x	x
Bouteloua diversispicula		x		x		Ca			Chl	x	x	
Bouteloua eludens		x				Na			Chl		x	
Bouteloua erecta		x				Na			Chl	x	x	
Bouteloua eriopoda			x	x		Na			Chl	x	x	
Bouteloua gracilis	x		x	x		A			Chl	x	x	x
Bouteloua hirsuta var. *glandulosa*	x		x			A			Chl	x	x	x
Bouteloua hirsuta var. *hirsuta*	x		x	x		Na			Chl	x	x	x
Bouteloua karwinskii			MDM	x	SA,SY	M	M		Chl	x		
Bouteloua media		x				Sa			Chl		x	

Especie	Comunidades vegetales: Bosque	Selva	Matorral	Pastizal	Otros	Origen: Nativa	End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
Bouteloua parryi var. *gentryi*				x		M	D,J,Si		Chl	x		
Bouteloua parryi var. *parryi*	x		x	x		Na			Chl	x	x	x
Bouteloua polymorpha	x	x		x		M	M		Chl	x	x	
Bouteloua radicosa	x	x		x		Na			Chl	x	x	x
Bouteloua ramosa			MDM		SA,SY	Na			Chl	x	x	x
Bouteloua reederorum			x	x		M	M		Chl	x	x	
Bouteloua repens	x	x	x	x		A			Chl	x	x	x
Bouteloua rigidiseta		x				Na			Chl	x		
Bouteloua scorpioides			x	x		M	M		Chl	x	x	x
Bouteloua simplex	x		x	x		A			Chl	x	x	x
Bouteloua trifida				x		Na			Chl		x	
Bouteloua uniflora var. *coahuilensis*	x		x	x		M	M		Chl	x	x	x
Bouteloua williamsii	x	x		x		Ca			Chl	x		
Bouteloua warnockii				x		Na			Chl		x	
Brachypodium mexicanum var. *mexicanum*	x		x	x		Sa			Poo	x	x	
Bromus anomalus	x	x		x		NA			Poo	x	x	x
Bromus arizonicus			x			Na			Poo		x	
Bromus carinatus var. *californicus*	x		x	x	VA, AD	Na			Poo	x	x	x
Bromus catharticus var. *catharticus*	x			x	AD	A			Poo	x	x	x
Bromus frondosus	x		MDM			Na			Poo		x	
Bromus marginatus				x		Na			Poo		x	
Bromus mucroglumis	x					Na			Poo	x		
Bromus porteri	x					Na			Poo	x		x
Bromus richardsonii	x					Na			Poo	x		x
Bromus thysanoglotis	x					M	D		Poo	x		
Calamagrostis divaricata	x					M	D		Poo	x		
Calamagrostis pringlei	x					M	M		Poo	x	x	x
Calamagrostis valida	x					Na			Poo	x		
Cenchrus brownii	x	x			AD	A		x	Poo	x	x	x
Cenchrus ciliaris		x	MDM		AD, VR	A		x	Poo	x	x	x
Cenchrus echinatus		x	x			A		x	Pan	x	x	x
Cenchrus incertus	x	x	x	x	AD	A		x	Pan	x	x	x

TABLA 1. *continuation*

Especie	Comunidades vegetales					Origen			Sub-familia	Dgo.	Zac.	Chih.
	Bosque	Selva	Matorral	Pastizal	Otros	Nativa	End-Émica	Exótica				
Cenchrus longispinus			x	x	SH	A		x	Pan	x		x
Cenchrus multiflorus		x				Ca			Pan	x	x	x
Cenchrus myosuroides var. *myosuroides*			MDM	x	AD	M	M		Pan	x		x
Cenchrus pilosus			MDM			Sa			Pan	x		
Chaboissaea decumbens	x				SA	M	M		Chl			x
Chaboissaea ligulata	x			x	SA	Sa			Chl	x	x	x
Chaboissaea subbiflora			x	x	SA	M	D		Chl	x		
Chaetium bromoides	x			x	VA	Ca			Pan			x
Chascolytrum subaristatum	x					A			Poo	x	x	
Chloris gayana	x		x	x		A		x	Chl	x	x	x
Chloris radiata	x					A			Chl			x
Chloris rufescens	x		MDM		T	Ca			Chl	x	x	
Chloris submutica	x		x	x	AD	A			Chl	x	x	x
Chloris virgata	x	x	x	x	VR	A			Chl	x	x	x
Cortaderia selloana					Or	A			Dan	x	x	x
Cottea pappophoroides		x	MDM			A			Chl	x	x	x
Ctenium planifolium	x					M	M		Chl		x	
Cynodon dactylon	x	x	x	x	VR	A		x	Chl	x	x	x
Cynodon plectostachyus					AC	A		x	Chl	x		
Dactylis glomerata					AC	A		x	Poo			x
Dactyloctenium aegyptium		x	x	x		A		x	Chl	x	x	x
Dactyloctenium radulans					AC	Na		x	Chl			x
Dasyochloa pulchella	x		x	x	VR	Na			Chl	x	x	x
Deschampsia danthonioides	x					Na			Poo			x
Deschampsia elongata	x					A			Poo			x
Deschampsia flexuosa	x					Na			Poo	x		
Dichanthelium acuminatum		x				A			Pan			x
Dichanthelium oligosanthes		x				Na			Pan			x
Dichanthelium sphaerocarpon var. *sphaerocarpon*	x					A			Pan	x	x	x
Dichanthium annulatum	x					A			Pan			x
Digitaria bicornis	x					A			Pan			x

Especie	**Bosque**	**Comunidades vegetales** **Selva**	**Matorral**	**Pastizal**	**Otros**	**Nativa**	**Origen** **End-Émica**	**Exótica**	**Sub-familia**	**Dgo.**	**Zac.**	**Chih.**
Digitaria californica var. *californica*		x	x	x	VR	A			Pan	x	x	x
Digitaria ciliaris	x	x		x	VR	A			Pan	x	x	x
Digitaria cognata			MDM	x		Na			Pan	x	x	
Digitaria filiformis	x			x		A			Pan	x	x	x
Digitaria insularis			x	x		A			Pan	x		x
Digitaria panicea		x		x		Ca			Pan	x	x	
Digitaria sanguinalis			x	x		A		x	Pan	x	x	x
Digitaria ternata	x		x	x		Sa		x	Pan	x	x	
Distichlis eludens					VA	M	D,SLP		Chl	x		
Distichlis littoralis				x		Na			Chl			x
Distichlis spicata var. *mexicana*			x	PH	VA	M			Chl	x	x	x
Distichlis spicata ssp. *stricta*				PH	VA	A			Chl	x		
Echinochloa colona	x	x	x	x	VA, VR	A			Pan	x	x	x
Echinochloa crusgalli var. *crusgalli*	x	x	x	x	VA, VR	A			Pan	x	x	x
Echinochloa crusgalli var. *zelayensis*	x	x	x	x	VA, VR	A			Pan	x	x	x
Echinochloa crus-pavonis var. *crus-pavonis*	x			x	VA	A			Pan	x		x
Echinochloa holciformis	x		x	x	VA, VR	Ca			Pan	x	x	x
Echinochloa jaliscana				x		M	J, Z		Pan		x	
Echinochloa muricata var. *microstachya*				x	VA	Na			Pan	x		x
Echinochloa oplismenoides	x		x	x	VA	Na			Pan	x	x	x
Echinochloa polystachya var. *polystachya*	x			x	T	A			Pan	x		x
Echinochloa walteri				x		A			Pan			x
Eleusine indica	x	x		x	T	A		x	Chl	x	x	x
Eleusine multiflora					AC	M		x	Chl	x	x	x
Elionurus barbiculmis	x		x	x		Na			Pan	x	x	x
Elionurus tripsacoides	x			x		A			Pan	x	x	x
Elymus arizonicus	x	x		x		Na			Poo	x	x	x
Elymus canadensis var. *canadensis*	x					Na			Poo			x
Elymus elymoides ssp. *brevifolius*	x		x			Na			Poo	x	x	x
Elymus repens ssp. *repens*	x			x	AD	A			Poo	x	x	x
Elymus riparius					VA	Na			Poo	x		
Elymus trachycaulus ssp. *trachycaulus*	x					Na			Poo			x

Tabla 1. *continuation*

Especie	Bosque	Selva	Matorral	Pastizal	Otros	Nativa	Origen End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
	Comunidades vegetales											
Enneapogon desvauxii	x		x	x	VR	A			Chl	x	x	x
Enteropogon chlorideus		x				Na			Chl		x	
Eragrostis barrelieri			x		VR	A		x	Chl	x	x	x
Eragrostis cilianensis		x	x	x	VR	A		x	Chl	x	x	x
Eragrostis ciliaris var. *ciliaris*		x				A		x	Chl	x		x
Eragrostis curvula		x		x	AC	A		x	Chl	x	x	x
Eragrostis erosa	x	x	x	x		Na			Chl	x	x	x
Eragrostis glandulosa			x			M	M		Chl	x		x
Eragrostis hirta			x			Na			Chl		x	
Eragrostis intermedia var. *appressa*	x	x	x	x		M	M		Chl		x	
Eragrostis intermedia var. *intermedia*	x	x	x	x		Na			Chl	x		x
Eragrostis intermedia var. *oreophila*			x	x		M	M		Chl			x
Eragrostis lehmanniana	x		x	x	AD	A		x	Chl	x		x
Eragrostis lugens	x	x	x	x		A			Chl	x	x	x
Eragrostis maypurensis		x		x	AD	A		x	Chl	x		
Eragrostis mexicana ssp. *mexicana*	x	x	x	x	VR	A			Chl	x	x	x
Eragrostis mexicana ssp. *virescens*	x					A			Chl			x
Eragrostis obtusiflora				x	SA	Na			Chl	x	x	x
Eragrostis palmeri	x		x	x		Na			Chl	x	x	x
Eragrostis pectinacea var. *miserrima*	x	x	x	x		A			Chl	x	x	x
Eragrostis pectinacea var. *pectinacea*	x	x	x	x		A			Chl	x	x	x
Eragrostis pilosa	x		x			A			Chl	x		x
Eragrostis plumbea	x			x		A			Chl		x	
Eragrostis pringlei	x					M	M		Chl	x	x	x
Eragrostis sessilispica			x	x		Na			Chl			x
Eragrostis spectabilis	x		x			Na		x	Chl			x
Eragrostis viscosa	x					Sa			Chl	x		
Eriochloa acuminata var. *acuminata*		x	x	x	VR, VA	Na			Pan	x	x	x
Eriochloa aristata var. *aristata*		x		x		Na			Pan	x		x
Eriochloa contracta	x		MDM			Na			Pan	x		x
Eriochloa lemmonii		x			T	Na			Pan	x		x
Eriochloa nelsonii var. *nelsonii*		x		x		Ca			Pan	x		x

Especie	Comunidades vegetales					Origen						
	Bosque	Selva	Matorral	Pastizal	Otros	Nativa	End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
Eriochloa punctata			MDM			A			Pan			x
Erioneuron avenaceum var. *avenaceum*	x	x	x			Na			Chl	x	x	x
Erioneuron nealleyi			MDM	x		Na			Chl	x	x	x
Erioneuron pilosum var. *pilosum*			MDM	x		Na			Chl		x	x
Festuca amplissima	x					Sa			Poo	x		x
Festuca arizonica	x					Na			Poo	x	x	
Festuca breviglumis		x				M	M		Poo	x		
Festuca diclina	x					M	Ch		Poo			x
Festuca lugens						M	M		Poo			x
Festuca pringlei	x					M	Ch,D		Poo	x	x	x
Festuca roblensis	x					M	G,Z		Poo		x	
Festuca rosei	x					Ca			Poo	x	x	
Festuca rubra	x	x				A			Poo	x		x
Festuca tolucensis	x		x			Sa			Poo	x		x
Glyceria borealis	x				VA	Na			Poo			x
Glyceria fluitans	x				VA	A			Poo	x		
Glyceria striata var. *striata*	x				VA	Na			Poo			x
Gouinia virgata var. *robusta*		x				M	M		Chl		x	
Gouinia virgata var. *virgata*		x				Ca			Chl	x		
Guadua angustifolia		x				M	M		Bam		x	
Hesperostipa neomexicana	x		MDM			Na			Poo			x
Hesperostipa spartea	x					Na			Poo	x		
Heteropogon contortus	x		x	x		A			Pan	x	x	x
Heteropogon melanocarpus	x	x	x	x		A			Pan	x	x	x
Hilaria belangeri var. *belangeri*			x			Na			Chl			x
Hilaria cenchroides	x		x	x		Na			Chl		x	
Hilaria ciliata	x					M	M		Chl			x
Hilaria swallenii	x			x		Na			Chl	x	x	x
Holcus lanatus					C	A		x	Poo			x
Hopia obtusa	x		x	x	VR	Na			Pan	x	x	x
Hordeum arizonicum			x		T	Na		x	Poo	x		
Hordeum jubatum	x			x	VR	A		x	Poo		x	

Tabla 1. continuation

Especie	Comunidades vegetales Bosque	Selva	Matorral	Pastizal	Otros	Origen Nativa	End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
Hordeum murinum ssp. *glaucum*				x		A		x	Poo			x
Hordeum vulgare					C	A		x	Poo		x	x
Hyparrhenia rufa		x				A		x	Pan	x		
Koeleria macrantha	x					Na			Poo			x
Koeleria pyramidata	x			x		NA			Poo	x	x	x
Lasiacis nigra		x				Sa			Pan	x	x	
Lasiacis procerrima		x		x	T	Sa			Pan	x		
Lasiacis ruscifolia		x				A			Pan	x		x
Leersia hexandra			x	x	VA, VR	A			Ehr	x	x	
Leptochloa aquatica				x	VA	M	M		Chl		x	
Leptochloa dubia	x		x	x		A			Chl	x	x	x
Leptochloa fusca ssp. *fascicularis*			x	x	VA,VR	A			Chl	x	x	x
Leptochloa fusca ssp. *uninervia*		x			VA	A			Chl	x	x	x
Leptochloa panicea ssp. *brachiata*		x		x	VR,T	A			Chl	x	x	x
Leptochloa panicea ssp. *mucronata*		x			VR,T	A			Chl	x		x
Leptochloa panicoides				x		A			Chl			x
Leptochloa scabra			x	x		A			Chl			x
Leptochloa viscida				x		Na			Chl			x
Lolium multiflorum	x		x	x		A		x	Poo	x	x	x
Lolium perenne					C	A		x	Poo	x	x	x
Lolium temulentum					AC	A		x	Poo		x	
Luziola fluitans	x			x		Na			Ehr		x	x
Lycurus phalaroides	x		x	x		A			Chl	x	x	x
Lycurus phleoides	x		x	x		NA			Chl	x	x	x
Lycurus setosus	x		x	x		A			Chl	x		x
Megathyrsus maximus	x				C	A		x	Pan	x		
Melica montezumae			x	x		Na			Poo			x
Melica porteri			x	x		Na			Poo			x
Melinis repens	x	x	x	x		A		x	Pan	x	x	x
Metcalfia mexicana	x					M	M		Poo		x	
Microchloa kunthii	x		x	x		A			Chl	x	x	x
Mnesithea granularis		x		x		A		x	Pan	x	x	x

	Comunidades vegetales					Origen						
Especie	**Bosque**	**Selva**	**Matorral**	**Pastizal**	**Otros**	**Nativa**	**End-Émica**	**Exótica**	**Sub-familia**	**Dgo.**	**Zac.**	**Chih.**
Mnesithea ramosa	x					Sa			Pan		x	
Muhlenbergia alamosae	x					M	M		Chl	x	x	x
Muhlenbergia annua	x					M	Ch,D		Chl	x		x
Muhlenbergia arenacea	x		x	x		Na			Chl		x	x
Muhlenbergia arenicola			x	x		Na			Chl	x	x	x
Muhlenbergia argentea	x					M	Ch		Chl			x
Muhlenbergia arizonica	x	x	x	x		Na			Chl	x		x
Muhlenbergia arsenei	x					Na			Chl			x
Muhlenbergia asperifolia				x	SA,SH	A			Chl	x		x
Muhlenbergia brevifolia		x				M	M		Chl	x		
Muhlenbergia brevis	x					Na			Chl	x	x	x
Muhlenbergia brevivaginata	x			x		M	M		Chl	x	x	
Muhlenbergia capillaris	x			x		A			Chl	x		x
Muhlenbergia capillipes	x					M	Ch		Chl			x
Muhlenbergia ciliata	x	x		x		Sa			Chl	x	x	x
Muhlenbergia crispiseta	x		x		BG	Na			Chl	x	x	x
Muhlenbergia depauperata	x		x	x		Na			Chl	x	x	x
Muhlenbergia distichophylla	x			x		Ca			Chl			x
Muhlenbergia diversiglumis	x	x		x	T	Sa			Chl	x	x	x
Muhlenbergia dubia	x					Na			Chl	x	x	x
Muhlenbergia dumosa	x	x				Na			Chl	x	x	x
Muhlenbergia durangensis	x					M	Ch,D,Z		Chl	x	x	x
Muhlenbergia elongata			x	x		Na	Ch, So		Chl			x
Muhlenbergia eludens	x					Na			Chl	x		x
Muhlenbergia emersleyi	x	x	x	x		Na			Chl	x	x	x
Muhlenbergia eriophylla	x					M	M		Chl	x	x	
Muhlenbergia filiformis	x					Na			Chl	x		
Muhlenbergia flavida	x	x				Na			Chl	x		x
Muhlenbergia flaviseta	x			x		M	Ch,D,Z		Chl	x	x	x
Muhlenbergia fragilis	x					Na			Chl	x	x	x
Muhlenbergia gigantea	x					M	M		Chl	x		
Muhlenbergia glauca	x		x	x		Na			Chl	x	x	x

Especie	Comunidades vegetales					Origen			Sub-familia	Dgo.	Zac.	Chih.
	Bosque	Selva	Matorral	Pastizal	Otros	Nativa	End-Émica	Exótica				
Muhlenbergia implicata	x					Sa			Chl	x	x	x
Muhlenbergia lindheimeri	x					Na			Chl			x
Muhlenbergia longiglumis	x					M	M		Chl	x	x	
Muhlenbergia longiligula	x					Na			Chl	x		x
Muhlenbergia lucida	x					M	M		Chl			x
Muhlenbergia macroura	x					Na			Chl	x		x
Muhlenbergia majalcensis	x					M	Ch		Chl			x
Muhlenbergia michisensis	x					M	D,G		Chl	x		
Muhlenbergia microsperma	x			x		A			Chl	x	x	x
Muhlenbergia minutissima	x	x				Na			Chl	x	x	x
Muhlenbergia montana	x	x		x		Na			Chl	x	x	x
Muhlenbergia mucronata	x					M	M		Chl	x	x	x
Muhlenbergia palmeri	x					Na			Chl	x		x
Muhlenbergia pauciflora	x				SA	Na			Chl	x		x
Muhlenbergia pectinata	x	x				Na			Chl	x		x
Muhlenbergia peruviana	x		x		BG	A			Chl	x	x	x
Muhlenbergia plumbea	x			x		Ca			Chl	x	x	
Muhlenbergia polycaulis	x	x	x	x	VR, T	Na			Chl	x	x	x
Muhlenbergia porteri			MDM		VR	Na			Chl	x	x	x
Muhlenbergia pubescens	x		x	x		M	M		Chl	x	x	x
Muhlenbergia pubigluma	x		x			M	M		Chl		x	x
Muhlenbergia quadridentata	x					Ca			Chl	x	x	x
Muhlenbergia ramulosa	x			x		A			Chl	x		x
Muhlenbergia reederorum	x					M	D,J,Mi		Chl	x		x
Muhlenbergia repens	x	x	x			Na			Chl	x	x	x
Muhlenbergia richardsonis			x		SA, T	Na			Chl	x		
Muhlenbergia rigens	x			x	VR,T	Na			Chl	x	x	x
Muhlenbergia rigida	x		x	x		A			Chl	x	x	x
Muhlenbergia robusta	x			x		Ca			Chl	x	x	x
Muhlenbergia schmitzii	x					M	M		Chl			x
Muhlenbergia scoparia	x					M	M		Chl	x	x	x
Muhlenbergia setifolia	x					Na			Chl	x		x

TABLA 1. *continuation*

Especie	Bosque	Selva	Matorral	Pastizal	Otros	Nativa	Origen End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
	Comunidades vegetales											
Muhlenbergia sinuosa	x					Na			Chl			x
Muhlenbergia speciosa	x	x		x		M	M		Chl	x	x	x
Muhlenbergia straminea	x					Na			Chl			x
Muhlenbergia stricta	x	x		x		M	M		Chl	x	x	
Muhlenbergia strictor	x					M	M		Chl	x		x
Muhlenbergia subaristata	x					M	M		Chl	x		
Muhlenbergia tarahumara	x					M	Ch		Chl			x
Muhlenbergia tenella		x		x		Sa			Chl	x		
Muhlenbergia tenuifolia	x	x	x	x	AD	A			Chl	x	x	x
Muhlenbergia texana	x			x		Na			Chl	x	x	x
Muhlenbergia torreyi	x			x	AD	A			Chl	x		x
Muhlenbergia utilis	x			x		Na			Chl	x	x	x
Muhlenbergia vaginata	x				VA	Ca			Chl	x		x
Muhlenbergia villiflora var. *villiflora*			x	x		M	M		Chl	x	x	x
Muhlenbergia virescens	x	x				Na			Chl	x	x	x
Muhlenbergia virletii	x					M	M		Chl	x		
Muhlenbergia wrightii	x					Na			Chl			x
Munroa squarrosa			MDM			Na			Chl			x
Nassella leucotricha	x					Na			Poo	x	x	
Nassella mucronata	x					Sa			Poo	x	x	
Nassella tenuissima	x					A			Poo	x	x	x
Oplismenus burmannii var. *burmannii*	x	x			BG	Sa			Pan	x	x	x
Oplismenus burmannii var. *nudicaulis*		x				Ca			Pan	x		x
Oplismenus compositus	x				VR, T	A			Pan	x		
Otatea acuminata ssp. *aztecorum*		x				M	M		Bam	x	x	x
Otatea fimbriata		x				Sa			Bam	x		
Panicum alatum var. *alatum*			MDM			Na			Pan	x		
Panicum alatum var. *minus*				x		A			Pan			x
Panicum antidotale				x	AC	A		x	Pan		x	
Panicum decolorans	x			x	VS, VR	M	M		Pan		x	x
Panicum dichotomiflorum				x	VS	A			Pan	x		x
Panicum elephantipes				x	VS	Sa			Pan		x	

Tabla 1. continuation

Especie	Comunidades vegetales Bosque	Selva	Matorral	Pastizal	Otros	Origen Nativa	End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
Panicum hallii var. *hallii*			x	x		Na			Pan	x		x
Panicum hirticaule var. *verrucosum*		x		x		Na			Pan	x	x	x
Panicum lepidulum	x	x	x	x		Ca			Pan	x	x	x
Panicum pampinosum	x					Na			Pan			x
Panicum parcum	x	x		x		Ca			Pan	x		x
Panicum plenum				x		Na			Pan	x		x
Panicum stramineum		x		x		A			Pan	x		x
Panicum trichoides		x				A			Pan	x		x
Panicum vaseyanum	x			x		M	M		Pan	x	x	x
Panicum virgatum	x		x	x		Na			Pan			x
Pappophorum bicolor			x	x	VR, VS	Na			Chl	x		x
Pappophorum vaginatum			x	x	VS	A			Chl	x	x	x
Paspalum arsenei		x				M	M		Pan		x	
Paspalum bootteri			x			Ca			Pan			x
Paspalum conjugatum		x				A			Pan	x		
Paspalum convexum	x	x		x		A			Pan	x	x	x
Paspalum crinitum				PH		M	M		Pan	x	x	
Paspalum denticulatum					VR	A			Pan	x	x	
Paspalum distichum	x	x	x	x	VA	A			Pan	x	x	x
Paspalum humboldtianum	x			x		Sa			Pan	x	x	
Paspalum jaliscanum	x			x		Ca			Pan	x	x	
Paspalum langei		x				A			Pan			x
Paspalum notatum	x					A			Pan	x	x	
Paspalum paniculatum		x				A			Pan		x	
Paspalum plicatulum	x	x				A			Pan	x	x	
Paspalum prostratum	x					Sa			Pan	x		
Paspalum pubiflorum		x			T	Na			Pan	x		x
Paspalum tenellum				x		SA			Pan		x	
Pennisetum clandestinum					Or	A		x	Pan	x	x	x
Pennisteum crinitum		x		x		M	M		Pan		x	x
Pennisteum durum	x					M	M		Pan			x
Pennisteum glaucum						A			Pan			x

Tabla 1. continuation

Especie	Comunidades vegetales Bosque	Selva	Matorral	Pastizal	Otros	Origen Nativa	End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
Pennisteum polystachion			x			A			Pan			x
Pennisetum villosum	x		x	x		A		x	Pan	x	x	
Pereilema ciliatum		x				Ca			Chl		x	
Pereilema crinitum	x	x		x		A			Chl	x	x	x
Peyritschia deyeuxioides	x		x	x	VR, T	Sa			Poo	x	x	x
Peyritschia pringlei	x			x	VR, T	Sa			Poo	x	x	x
Phalaris angusta				x		A			Poo			x
Phalaris aquatica					VA	A			Poo			x
Phalaris arundinacea				x		A			Poo			x
Phalaris canariensis			x	x		A		x	Poo	x		x
Phalaris carolineana		x		x		Na			Poo			x
Phalaris paradoxa				x		A			Poo			x
Phragmites australis			x		VA	A			Aru	x		x
Phyllostachys aurea					Or	A			Bam		x	
Piptochaetium brevicalyx ssp. *flexuosum*	x					M	D		Poo	x		
Piptochaetium fimbriatum	x	x	x	x		Na			Poo	x	x	x
Piptochaetium pringlei	x					Na			Poo	x		x
Piptochaetium virescens var. *virescens*	x					Ca			Poo	x	x	
Pleuraphis mutica			MDM	x	SA, SY	Na			Chl	x	x	x
Pleurhaphis rigida				x		M	M		Chl			x
Poa annua	x		x	x		A			Poo	x	x	x
Poa bigelovii	x	x				Na			Poo			x
Poa fendleriana ssp. *albescens*	x			x		Na			Poo			x
Poa fendleriana ssp. *fendleriana*	x	x				Na			Poo			x
Poa matri-occidentalis ssp. *mohinorensis*	x					M	Ch		Poo			x
Poa matri-occidentalis ssp. *matri-occidentalis*	x					M	D		Poo	x		
Poa pratensis	x			x	C	A			Poo			x
Poa strictiramea	x					Na			Poo	x	x	x
Polypogon elongatus	x		x		T	A			Poo	x	x	x
Polypogon interruptus			x		VS	A			Poo	x		
Polypogon monspeliensis	x		x	x	VS	A		x	Poo	x	x	x
Polypogon viridis	x		x	x	T	A		x	Poo	x	x	x
Rhipidocladum racemiflorum			x		VS	A			Bam	x		

Tabla 1. *continuation*

Especie	Comunidades vegetales					Origen						
	Bosque	Selva	Matorral	Pastizal	Otros	Nativa	End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
Saccharum officinarum					C	A		x	Pan		x	
Schedonorus arundinaceus					Or	A			Poo		x	
Schismus arabicus			MDM			A			Dan			x
Schismus barbatus			x			A		x	Dan			x
Schizachyrium brevifolium	x			x		Sa		x	Poo		x	
Schizachyrium cirratum	x			x		A			Pan	x	x	x
Schizachyrium mexicanum		x				M	M		Pan			x
Schizachyrium sanguineum	x	x		x		A			Pan	x	x	x
Schizachyrium scoparium var. *neomexicanum*	x			x		Na			Pan	x		x
Schizachyrium semitectum	x					Ca			Pan			x
Schizachyrium tenerum	x		x	x	BG	A			Pan	x	x	x
Scleropogon brevifolius			x	PH		A			Chl	x	x	x
Scolochloa festucacea	x				BG	Na			Poo	x		
Setaria adhaerens			x		VR, VS	A			Pan	x	x	x
Setaria grisebachii	x	x	x	x	VR	A			Pan	x	x	x
Setaria latifolia		x				M	M		Pan	x		
Setaria leucopila		x	x	PH		A			Pan	x	x	x
Setaria liebmannii	x					A			Pan	x		x
Setaria macrostachya		x	x	x		A			Pan	x	x	x
Setaria parviflora	x	x	x	x	AD	A			Pan	x	x	x
Setaria scheelei		x	x		VR, VS	Na			Pan	x		
Setaria verticillata			MDM			A		x	Pan	x		x
Setaria villosissima			x			Na			Pan			x
Setaria viridis			x			A		x	Pan	x		x
Setariopsis auriculata			x			A			Pan		x	x
Setariopsis latiglumis		x				M	M		Pan		x	x
Sorghastrum brunneum	x					Ca			Pan	x		
Sorghastrum incompletum var. *incompletum*		x				Sa			Pan		x	
Sorghastrum nudipes	x					M	Ch		Pan			x
Sorghastrum nutans	x		x	x		A			Pan	x	x	x
Sorghum bicolor			MDM	x		A		x	Pan	x	x	x
Sorghum halepense	x		x	x		A		x	Pan	x	x	x
Spartina cynosuroides	x					Na			Chl			x

TABLA 1. continuation

Especie	Comunidades vegetales: Bosque	Selva	Matorral	Pastizal	Otros	Origen: Nativa	End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
Spartina gracilis	x					Na			Chl			x
Sphenopholis obtusata			x			Na			Poo	x		x
Sporobolus airoides var. *airoides*			x	PH		Na			Chl	x	x	x
Sporobolus atrovirens	x		x	x		M	M		Chl	x	x	
Sporobolus coahuilensis			x		SY	M	D,Co		Chl	x		
Sporobolus contractus			x	x		Na			Chl	x		x
Sporobolus cryptandrus			x	PH		A			Chl	x	x	x
Sporobolu flexuosus			MDM			Na			Chl	x		x
Sporobolu giganteus			x	x		Na			Chl			x
Sporobolus indicus var. *indicus*	x	x	x	x		A			Chl	x	x	x
Sporobolus macrospermus	x		MDM	x		Ca			Chl	x	x	
Sporobolus palmeri			x		SA, SY	M	M		Chl	x	x	
Sporobolus pyramidatus			x	PH	SA,VR,VS	A			Chl	x	x	x
Sporobolu spiciformis			MDM			M	Ch,Co,D		Chl	x		x
Sporobolus trichodes	x			x		M	M		Chl	x	x	x
Sporobolus wrightii			x	x	SA	NA			Chl	x	x	x
Steinchisma cuprea	x			x		M	M		Pan	x		
Thinopyrum intermedium	x					A			Poo			x
Torreyochloa pallida var. *pauciflora*	x				VA	Na			Poo	x		
Trachypogon spicatus	x	x	x	x		A			Pan	x	x	x
Tragus berteronianus			x	x	VR	A		x	Chl	x	x	x
Trichloris crinita			MDM			A			Chl	x		x
Trichloris pluriflora			MDM			A			Chl	x		x
Tridens albescens			MDM			Na			Chl	x		x
Tridens muticus			x	x	VR	Na			Chl	x	x	x
Tridens texanus			x	x		Na			Chl			x
Triniochloa laxa	x					M	Ch		Poo			x
Tripogon spicatus			x	x		A			Chl	x	x	
Tripsacum dactyloides var. *dactyloides*	x	x	x	x	T	Na			Pan	x	x	x
Tripsacum lanceolatum	x		x	x		Na			Pan	x	x	x
Tripsacum pilosum	x	x				Na			Pan	x	x	
Tripsacum zopilotense	x			x		Ca			Pan	x	x	x
Trisetum durangense	x					M	D		Poo	x		

Especie	Comunidades vegetales Bosque	Selva	Matorral	Pastizal	Otros	Origen Nativa	End-Émica	Exótica	Sub-familia	Dgo.	Zac.	Chih.
Trisetum filifolium var. *aristatum*	x					M	Ch,D		Poo	x		x
Trisetum irazuense	x					Sa			Poo	x		
Trisetum martha-gonzaleziae	x					M	D		Poo	x		
Trisetum palmeri	x					M	M		Poo	x		x
Trisetum spellenbergii	x					M	Ch		Poo			x
Trisetum spicatum	x					A			Poo	x		x
Trisetum viride	x			x		Ca			Poo	x		x
Trisetum virletti	x					M	M		Poo	x		x
Tristachya laxa		x				M	D,N,Si		Pan	x		
Triticum aestivum	x		x		C	A		x	Poo	x	x	x
Urochloa arizonica		x	x	x	VS	Na			Pan	x		x
Urochloa discifera	x					M	M		Pan	x		
Urochloa fusca	x	x	x	x	VR	A			Pan	x	x	x
Urochloa meziana	x		x	x		M	M		Pan	x	x	x
Urochloa panicoides			x	x		A			Pan		x	
Urochloa plantaginea		x	x	x	T	A			Pan	x	x	x
Urochloa texana	x		x	x	VS	Na			Pan	x	x	x
Vulpia microstachys	x			x		Na			Poo	x		
Vulpia myuros var. *hirsuta*	x			x		Sa			Poo	x	x	x
Vulpia octoflora					VS	Na			Poo			x
Zea mays ssp. *mays*					C	A			Pan	x	x	x
Zea mays ssp. *mexicana*	x			x	AC	M	M		Pan	x		x
Zuloagaea bulbosa	x		x	x	BG	A			Pan	x	x	x

Por su origen nativas en: **A**= América*, **C**= Cosmopolita, **Ca**= Centroamérica**, **M**= México, **Na**= Norteamérica***, **Sa**= Sudamérica****
América*= distribución en todo el continente americano
Centroamérica**= distribución en México y Centroamérica
Norteamérica***= desde Canadá o Estados Unidos hasta México o hasta Centroamérica
Sudamérica****= desde México hasta Sudamérica
Endémicas en los Estados de: **Ch**= Chihuahua, **Co**= Coahuila, **D**= Durango, **G**= Guerrero, **J**= Jalisco, **Mi**= Michoacán, **N**= Nayarit, **Si**= Sinaloa, **SLP**= San Luis Potos, **So**= Sonora, **Z**= Zacatecas
Otros: **AC**= área de cultivo, **AD**= área de disturbio, **BG**= bosque de galería, **C**= Cultivado, **Or**= Ornamental, **SA**= suelos alcalinos, **SH**= suelos halófilos, **SY**= suelos yesosos, **VA**= vegetación acuática, **VR**= vegetación riparia, **VS**= vegetación subacuática, **T**= tolerante (subsiste en medios secos y acuosos por igual).

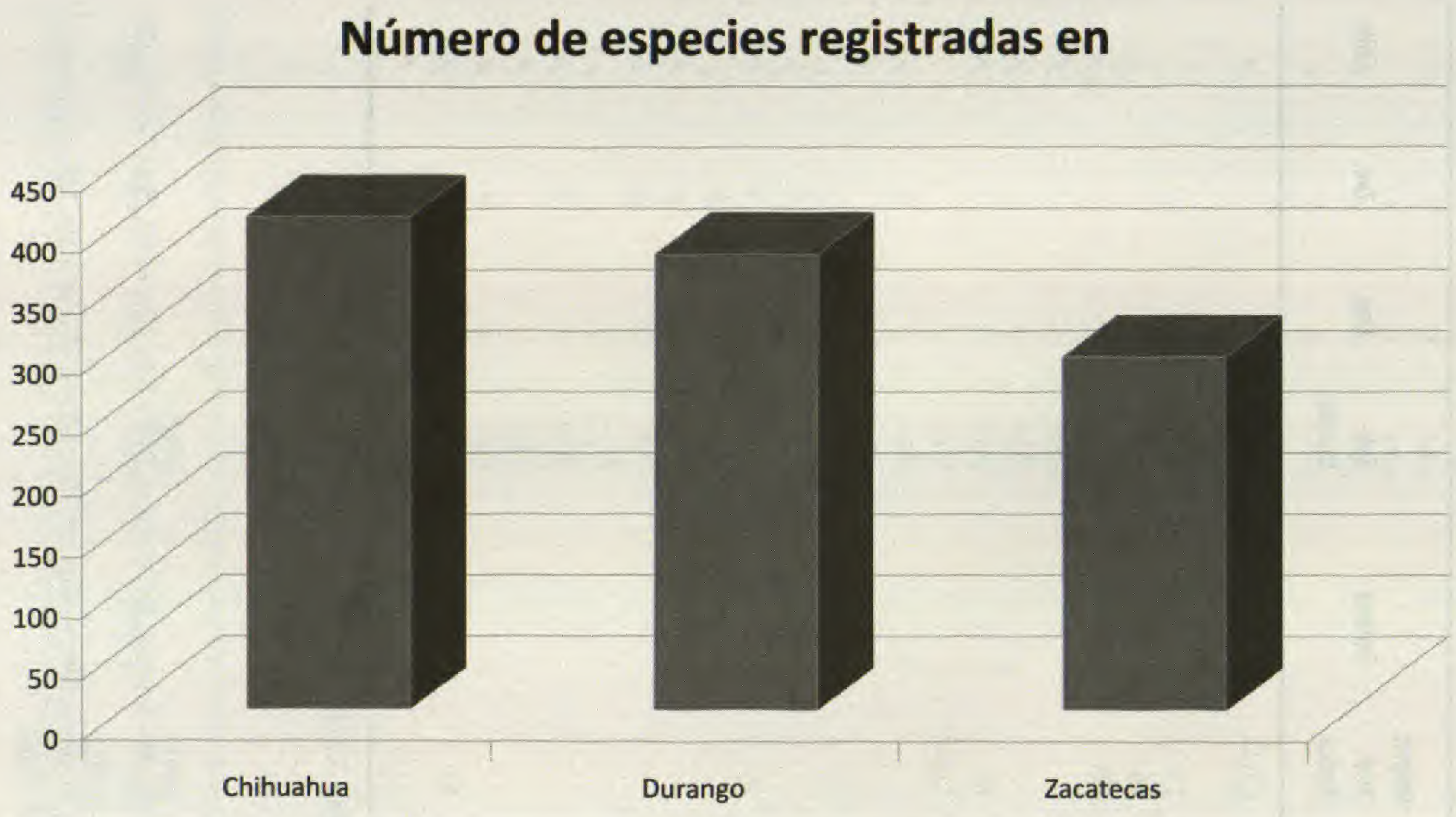

Fig. 2. Porcentajes de especies encontradas en cada estado de la región.

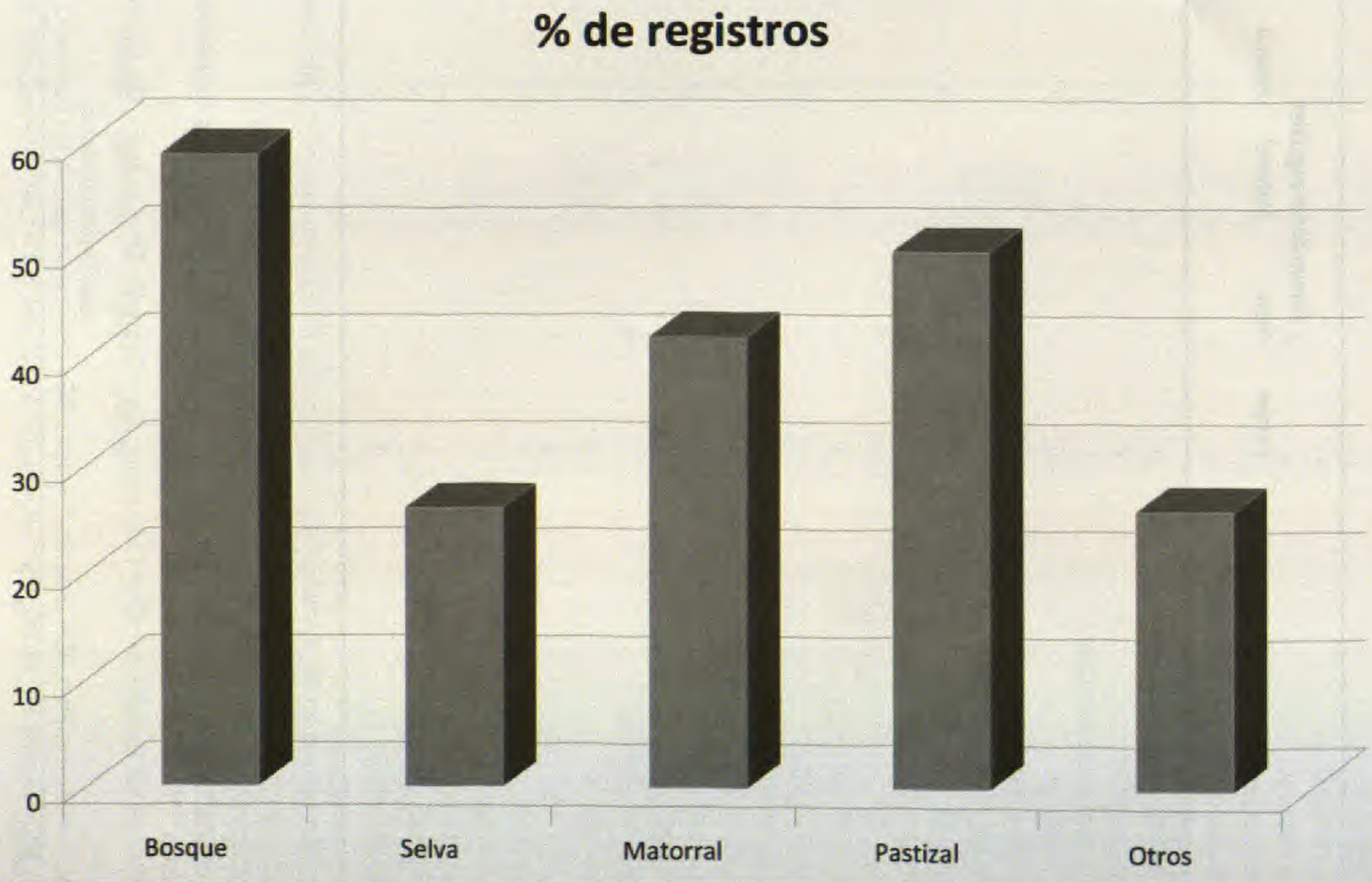

Fig. 3. Porcentaje de especies distribuidas en los ecosistemas de la región.

"región de las quebradas". En las estribaciones occidentales de la Sierra Madre Occidental, a lo largo del límite entre Durango y Sinaloa y en el cañón o Barranca del Cobre (Chihuahua). En un intervalo altitudinal de 300 a 1400 m s.n.m.

Se registran las siguientes especies de los 28 géneros que forman parte de la vegetación del bosque tropical caducifolio: *Aristida gibbosa, Arundinella hispida, Arundo donax* f. *versicolor, Axonopus mexicanus, Bothriochloa ischaemum, Bouteloua eludens, B. erecta, B. media, Cenchrus multiflorus, Dichanthelium oligosanthes, Enteropogon chlorideus, Eragrostis ciliaris, Eriochloa lemmonii, Festuca breviglumis, Gouinia virgata, Guadua angustifolia, Hyparrhenia rufa, Lasciacis nigra, L. ruscifolia, Leptochloa fusca* ssp. *uninervia, L. panicea* ssp. *mucronata, Muhlenbergia brevifolia, Oplismenus burmannii* var. *nudicaulis, Otatea acuminata, Panicum trichoides, Paspalum arsenei, P. conjugatum, P. paniculatum, P. pubiflorum, Pereilema ciliatum, Schizachyrium mexicanum, Setaria latifolia, Setariopsis latiglumis, Sorghastrum incompletum* y *Tristachya laxa.*

Las especies adventicias encontradas en la vegetación secundaria son: *Bothriochloa ischaemum, Eragrostis ciliaris* y *Hyparrhenia rufa.*

En esta comunidad es donde se encuentra la menor riqueza de gramíneas de la región, porque son en realidad escasas ó debido a que las colectas son escasas, como consecuencia de su fisiografía, de pendientes escarpadas y de difícil acceso.

Pastizales

Son comunidades que se distribuyen en la región de los valles, en la vertiente Este o interior de la Sierra Madre Occidental. Son zonas con precipitación anual entre 300 y 400 mm anuales, en altitudes entre 1800 y 2000 m s.n.m.

En este tipo de vegetación es donde se encuentra la mayor variación de pastos naturales, es decir de origen primario, aquí se distribuye la mayoría de las especies de los géneros: *Aristida, Bouteloua, Elionurus, Eragrostis, Heteropogon, Hilaria, Lycurus* y *Mnesithea*, y algunas especies de los géneros: *Bothriochloa, Chloris, Digitaria, Erioneuron, Muhlenbergia, Paspalum, Setaria, Sporobolus, Tridens* y *Urochloa.*

Especies que parecen ser exclusivas del pastizal: *Achnatherum curvifolium, Aegilops cylindrica, Aristida purpurea* var. *fendleriana, Bouteloua parryi* var. *gentryi, B. trifida, B. warnockii, Bromus inermis, B. japonicus, B. marginatus, Distichlis littoralis, Echinochloa jaliscana, E. muricata* var. *microstachya, E. walteri, Eragrostis obtusiflora, E. superba, Hordeum pusillum, Leptochloa aquatica, L. panicoides, L. viscida, Muhlenbergia asperifolia, Panicum alatum, P. dichotomiflorum, P. elephantipes, P. plenum, Paspalum crinitum, P. tenellum, Phalaris arundinacea* y *Sporobolus fimbriatus.*

Las especies compartidas entre el pastizal y el matorral xerófilo son zacates adaptados a condiciones de menor humedad que en el caso anterior, a condiciones de disturbio o a una combinación de ambas. Las especies presentes son de los géneros: *Aristida purpurea* var. *longiseta, A. purpurea* var. *wrightii, A. ternipes* var. *gentilis, A. ternipes* var. *ternipes, Arundinella berteroniana, Bothriochloa hybrida, B. laguroides* var. *torreyana, B. palmeri, Bouteloua aristidoides, B. barbata, B. breviseta, B. curtipendula, B. eriopoda, B. reederorum, B. scorpioides, Cenchrus longispinus, Chaboissaea subbiflora, Digitaria insularis, D. sanguinalis, Distichlis spicata, Eragrostis intermedia* var. *oreophila, E. sessilispica, Erioneuron nealleyi, E. pilosum, Leersia hexandra, Leptochloa fusca* ssp. *fascicularis, L. scabra, Melica montezumae, M. porteri, Muhlenbergia arenicola, M. elongata, M. villiflora, Panicum hallii, Pappophorum bicolor, P. vaginatum, Phalaris canariensis, Pleuraphis mutica, Scleropogon brevifolius, Sorghum bicolor, Sporobolus airoides, S. contractus, S. cryptandrus, S. giganteus, S. pyramidatus, S. wrightii, Tragus berteronianus, Tridens muticus, T. texanus, Tripogon spicatus* y *Urochloa panicoides.*

Las especies *Cenchrus longispinus, Distichlis spicata, Muhlenbergia asperifolia, Paspalum crinitum, Scleropogon brevifolius, Setaria leucopila, Sporobolus airoides, S. cryptandrus* y *S. pyramidatus* son específicas de suelos salinos de pastizales y matorrales.

Específicas de suelos yesosos son *Aristida gypsophila, Bouteloua chasei* y *Sporobolus coahuilensis*; en suelos alcalinos o yesosos las especies: *Bouteloua karwinski, B. ramosa, Chaboissaea decumbens, Ch. ligulata, Ch. subbiflora, Eragrostis obtusiflora, Muhlenbergia asperifolia, M. pauciflora, M. richardsonis, Pleuraphis mutica, Sporobolus palmeri, S. pyramidatus, S. wrightii.*

Matorrales Xerófilos

Los matorrales xerófilos, se encuentran en elevaciones entre 1000 y 1800 m s.n.m., con precipitaciones pluviales de 200 a 400 mm anuales. El Desierto Chihuahuense, es una comunidad dominada por matorral desértico micrófilo y/o matorral desértico rosetófilo; los matorrales más secos de la región. En general son las comunidades que reciben menores precipitaciones pluviales (100 a 200 mm anuales).

En los matorrales se encontraron las siguientes especies: *Aristida gypsophila, A. pansa, Bothriochloa alta, B. longipaniculata, Bromus arizonicus, Eragrostis barrelieri, E. glandulosa, E. hirta, Hilaria belangeri, Hordeum arizonicum, Muhlenbergia richardsonis, Paspalum bootteri, Pennisetum polystachion, Phragmites australis, Polypogon interruptus, Rhipidocladum racemiflorum, Schismus barbatus, Setaria adhaerens, S. villosissima, S. viridis, Setariopsis auriculata, Sphenopholis obtusata, Sporobolus coahuilensis* y *S. palmeri.*

Las especies encontradas en el matorral del Desierto Chihuahuense son: *Aristida purpurea* var. *perplexa, Blepharidachne bigelovii, Bouteloua chasei, B. chihuahuana, B. karwinski, B. ramosa, Bromus frondosus, Cenchrus ciliaris, C. myosuroides, C. pilosus, Chloris rufescens, Cottea pappophoroides, Digitaria cognata, Eriochloa contracta, E. punctata, Erioneuron nealleyi, E. pilosum, Hesperostipa neomexicana, Muhlenbergia porteri, Munroa squarrosa, Panicum alatum, Pleuraphis mutica, Schismus arabicus, Setaria verticillata, Sorghum bicolor, Sporobolus flexuosus, S. macrospermus, S. spiciformis, Trichloris crinita, T. pluriflora* y *Tridens albescens.* De la región de dunas (Samalayuca): *Achnatherum hymenoides*

Especies favorecidas por las actividades humanas, son las siguientes:

Zacates Cultivados y/o Escapados de Cultivo y Arvenses

Las especies que fueron introducidas como cultivo para alimento humano o forraje son: *Avena sativa* (avena), *Chloris gayana* (zacate rhodes), *Cynodon dactylon* (zacate bermuda), *Cynodon plectostachyus* (estrella africana), *Dactyloctenium aegyptium* (zacate egipcio), *Hordeum vulgare* (cebada), *Lolium multiflorum* (rye grass), *Megathyrsus maximus* (zacate guinea), *Panicum antidotale* (pánico azul), *Phalaris canariensis* (alpiste), *Sorghum bicolor* (sorgo), *S. halepense* (zacate Johnson) y *Triticum aestivum* (trigo).

Las especies cultivadas como ornamentales en jardines son: *Arundo donax* (carricillo), *Cortaderia selloana* (pasto de las pampas), *Cenchrus ciliaris* (buffel), *Pennisetum clandestinum* (kikuyo), *Phalaris canariensis* (alpiste) y *Saccharum officinarum* (azúcar).

Especies Introducidas.

Anthoxanthum odoratum, Avena fatua, Bothriochloa ischaemum, Cenchrus brownii, C. echinatus, C. longispinus, Dactylis glomerata, Eragrostis barrelieri, E. curvula, E. lehmanniana, E. spectabilis, Holcus lanatus, Holcus lanatus, Hordeum arizonicum, H. jubatum, H. murinum ssp. *glaucum, Hyparrhenia rufa, Lolium temulentum, Melinis repens, Mnesithea granularis, Panicum antidotale, Pennisetum villosum, Polypogon monspeliensis, P. viridis, Schismus barbatus* y *Schizachyrium brevifolium* son especies no nativas cuya introducción en la región es probablemente reciente, considerando el tiempo que llevó la formación natural de los pastizales. Generalmente son originarias de África y Eurasia e introducidas involuntariamente, mezcladas con semillas de praderas cultivadas.

Especies introducidas que se comportan como malezas en terrenos de cultivo o en áreas de disturbio en diversos tipos de vegetación como: *Avena fatua, Cenchrus ciliaris, C. incertus, C. myosuroides, Digitaria ciliaris, D. filiformis, D. sanguinalis, D. ternata, Eleusine indica, E. multiflora, Eragrostis cilianensis, E. ciliaris, E. maypurensis, Lolium perenne, Setaria adhaerens, S. verticillata, S. viridis, Sorghum halepense* y *Tragus berteronianus.*

Otro grupo de especies importantes son las favorecidas por la presencia de agua:

Especies Acuáticas, Subacuáticas o Tolerantes

Son especies que se encuentran en condiciones húmedas hasta llegar a estar sumergidas, a veces de forma intermitente, ya que las lagunas, canales o escurrimientos en esta región permanecen secos la mayor parte del año. En la Tabla 1 del Anexo se marcan 24 especies acuáticas con VA, 14 subacuáticas con VS y 21 tolerantes con T. De este tipo de microhábitat se encuentran 42 taxa con VR que indica son de vegetación riparia y 7 más con BG del bosque de galería.

De lo más importante a mencionar son las especies endémicas o raras que pudieran estar amenazadas por lo reducido de su distribución.

Endemismos y Especies Escasas o Raras

Las especies endémicas de la región son: 1) del estado de Chihuahua: *Festuca diclina, Muhlenbergia argentea, M. capillipes, M. majalcensis, M. tarahumara, Poa matri-occidentalis* ssp. *mohinorensis, Sorghastrum nudipes, Triniochloa laxa, Trisetum spellenbergii.* 2) del estado de Durango: *Bromus thysanoglottis, Calamagrostis divaricata, Chaboissaea subbiflora, Muhlenbergia michisensis, Piptochaetium brevicalyx* subsp. *flexuosum, Poa matri-occidentalis* ssp. *matri-occidentalis, Trisetum durangense, T. martha-gonzaleziae.* 3) del estado de Zacatecas: Festuca roblensis. Endémicas de los humedales de Durango y San Luis Potosí: *Distichlis eludens*; de los bosques de pino piñonero de Durango y Zacatecas: *Agrostis rosei*; de los pastizales de Zacatecas y Jalisco: *Echinochloa jaliscana*; de los pastizales y matorrales de Chihuahua y Sonora: *Muhlenbergia elongata*; y del matorral xerófilo sobre suelos yesosos de Durango y Coahuila: *Sporobolus coahuilensis*.

Son especies endémicas de bosque de pino en la Sierra Madre Occidental en Durango y Chihuahua: *Aristida spanospicula, Bealia mexicana, Blepharoneuron shepherdii, Festuca pringlei, Muhlenbergia annua, Trisetum filifolium* var. *aristatum*. Compartiendo con Zacatecas: *Muhlenbergia durangensis, M. flaviseta*. Compartiendo con Coahuila en el área de matorral desértico micrófilo: *Sporobolus spiciformis*.

Es endémica del bosque tropical caducifolio de los estados de Durango y Jalisco: *Muhlenbergia reederorum*, y de Durango, Jalisco y Sinaloa: *Bouteloua parryi* var. *gentryi*; de Durango, Nayarit y Sinaloa: *Tristachya laxa*.

Especies escasas que habitan en los pastizales o matorrales aledaños a las poblaciones y por lo tanto sujetas al estrés de la colonización urbana son: *Muhlenbergia arenicola, Scleropogon brevifolius, Sporobolus palmeri, Tripogon spicatus*.

Finalmente es importante mencionar que las especies colectadas en los alrededores de las ciudades capitales de los 3 estados, a finales del Siglo XIX y/o pricipios del XX, y que no han sido encontradas en colectas recientes son: *Echinochloa crus-pavonis, Eragrostis viscosa, Koleria pyramidata, Muhlenbergia richardsonis, Panicum plenum, Tripsacum pilosum*.

Los taxa (especies e infraespecies) de gramíneas encontradas en la región norte-centro de México son por su origen principalmente de tipo nativo con 372 especies (70%), y en menor proporción endémicas con 106 especies (20%) y exóticas con 56 especies (10%) como se aprecia en la Figura 4.

La pequeña proporción de taxa introducidos que muestra la gráfica anterior, podría suponer que las comunidades vegetales en Durango no se encuentran deterioradas; sin embargo, para estimar el grado de perturbación de los pastizales, bosques y matorrales se requieren muestreos cuantitativos con mediciones de cobertura, densidad y frecuencia para cada taxón, con el objetivo de determinar el grado de invasión de estas especies.

La distribución de las especies nativas por su distribución a nivel continente, se muestra en la Figura 5.

En el análisis de la distribución de las subfamilias, las de la Chloridoideae (Fig. 6) de afinidades hacia los ambientes tropicales y subtropicales más áridos, es la mejor representada en la región con un 42 % de las especies; sus especies cuentan con un sistema de fotosíntesis C_4 que les permite optimizar el uso del agua, adaptarse y sobrevivir en condiciones de clima seco y semiseco que imperan en la región. La subfamilia Panicoideae de afinidad a los ambientes tropicales, cuya distribución austral es más generalizada, le sigue en importancia por presentarse en la región con un 28% de las especies, presentan el sistema de fotosíntesis C_3 y C_4; se encuentra bien representada en los pastizales y bosques. La subfamilia Pooideae de afinidad en ambientes templados y generalizada distribución boreal, es la tercera en importancia en la región, ya que cuenta con el 22% de las especies, con un sistema fotosintético C_3, está bien representada en los bosques templados. Por último las subfamilias Aristidoideae con un 5% y Arundinoide, Bambusoideae y Pharoideae poco representadas con 1% de las especies, lo que se explica por tratarse de subfamilias cuyo origen y distribución se presenta en ecosistemas tropicales húmedos y hábitats acuáticos.

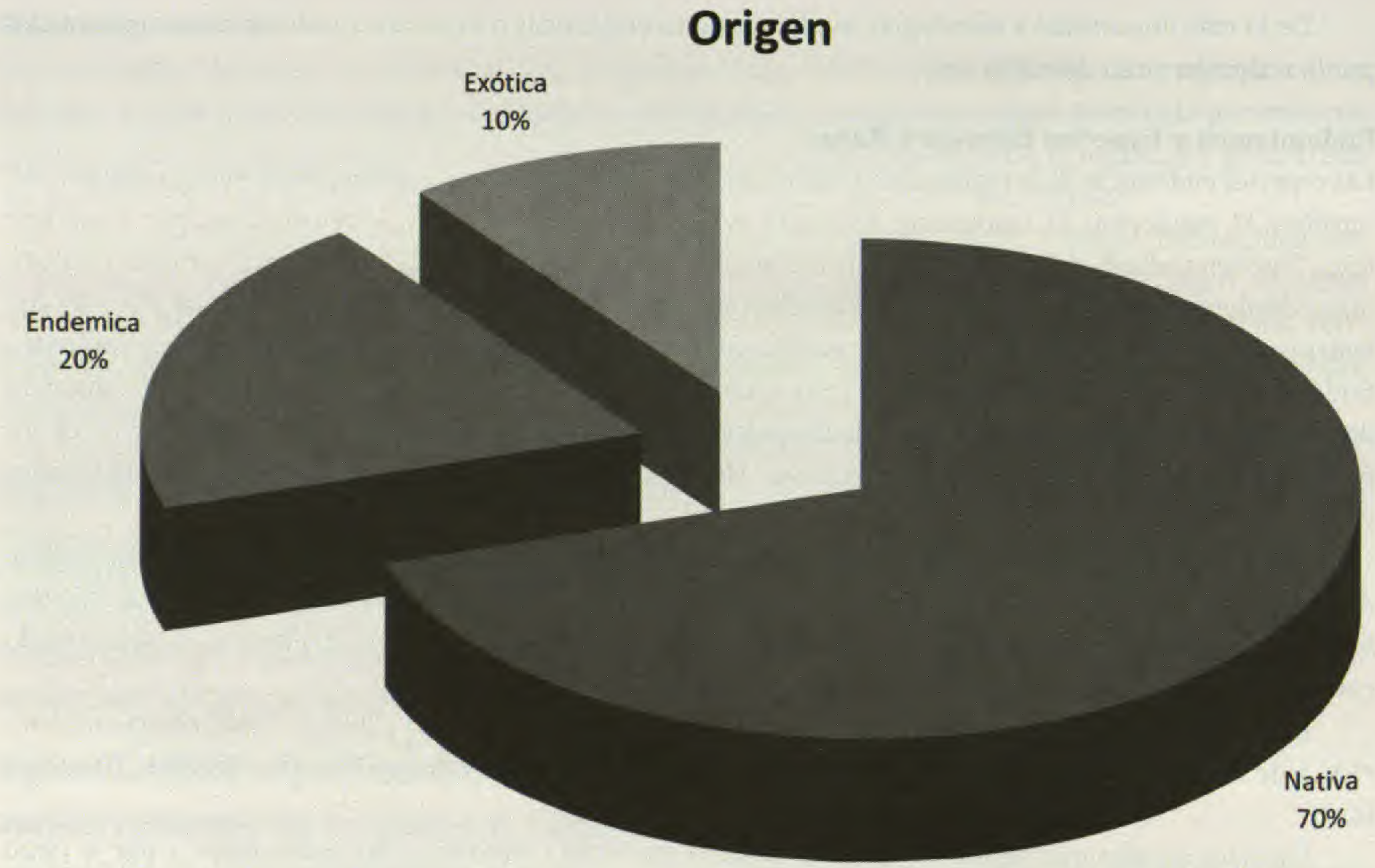

Fig. 4. Porcentaje de gramíneas en el norte-centro de México según su origen.

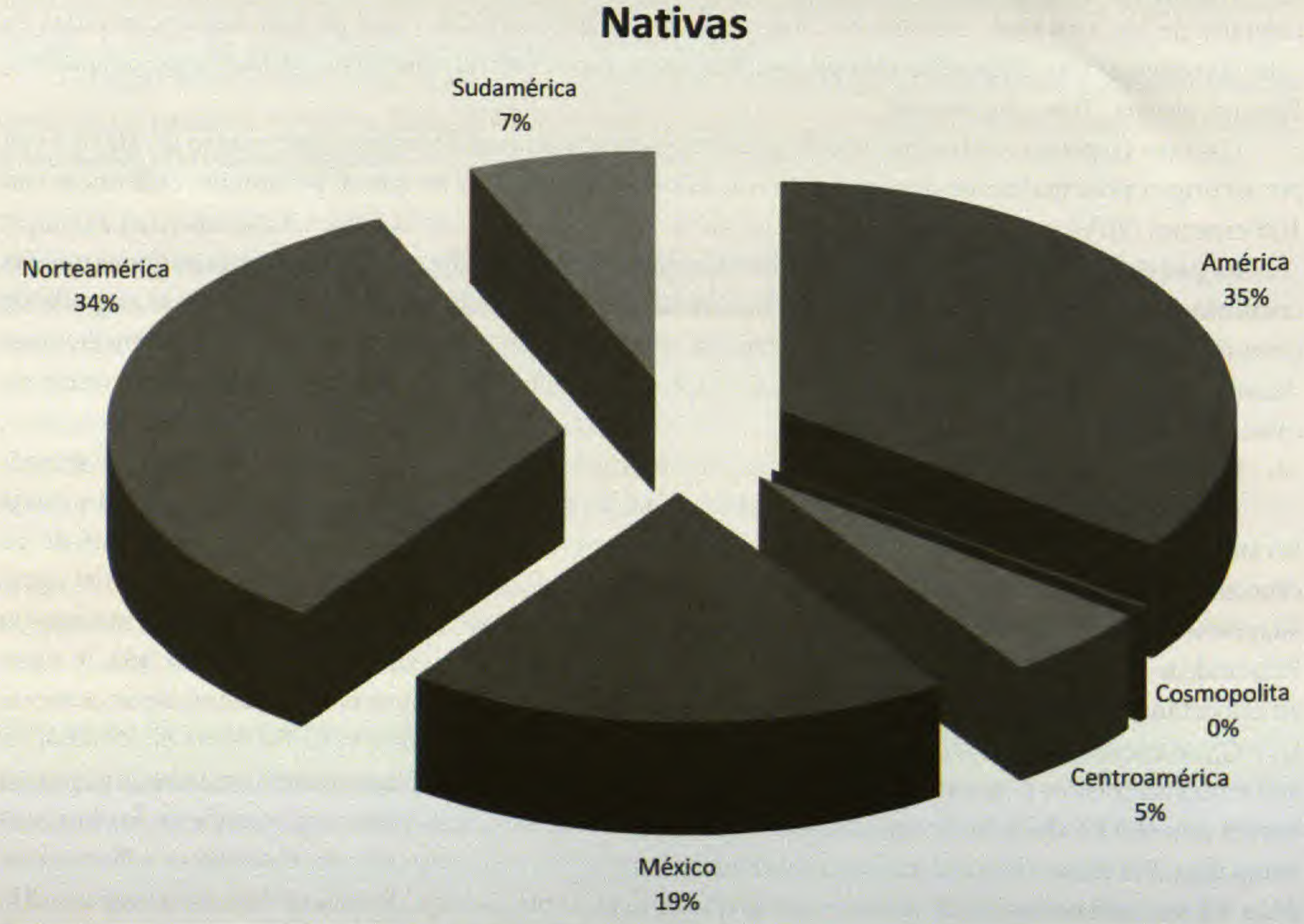

Fig. 5. Especies nativas por su distribución a nivel continente.

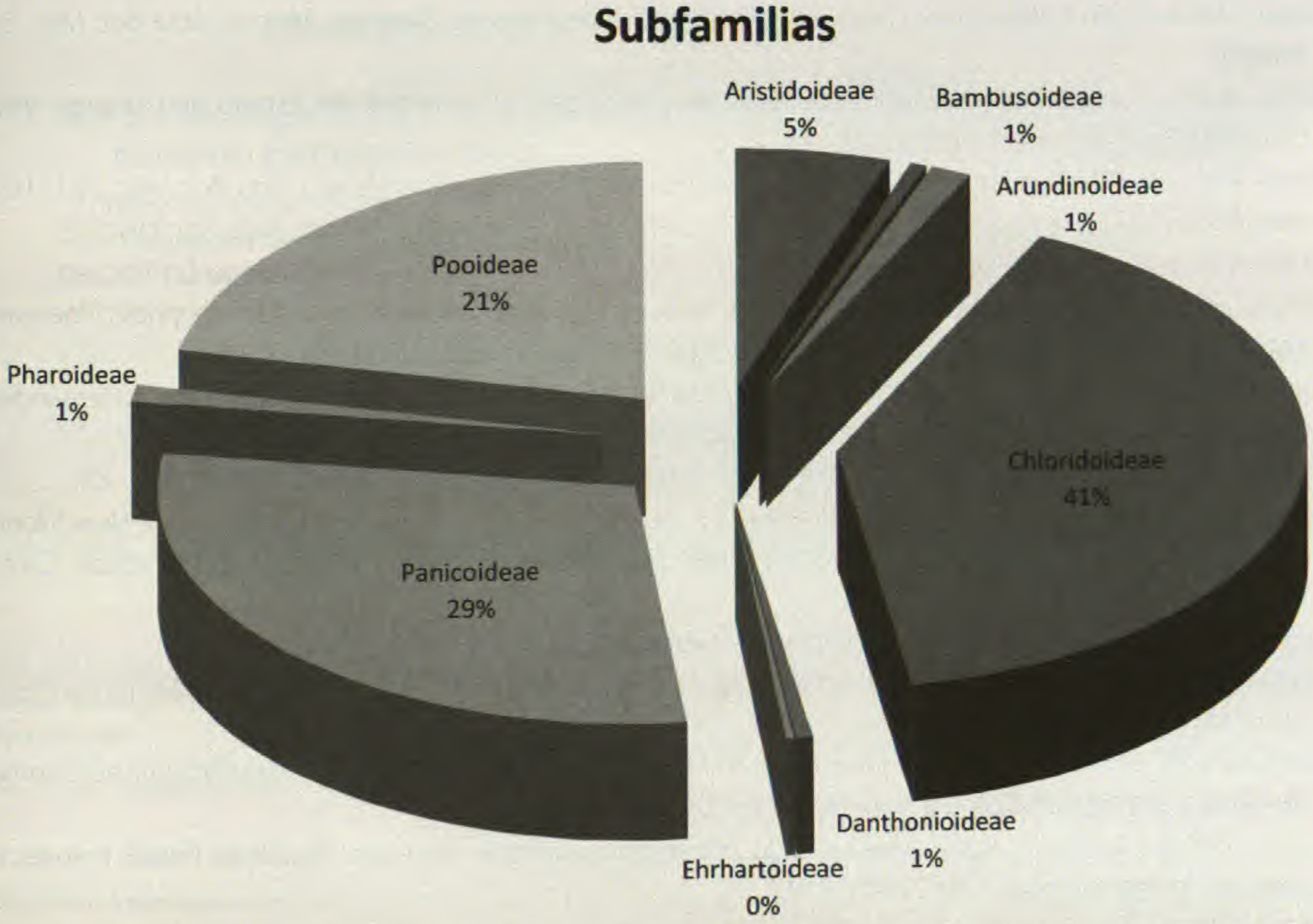

Fig. 6. Distribución de las subfamilias de Poaceae.

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REFERENCIAS

Bell, H.L. y J.T. Columbus. 2008. Proposal for an expanded *Distichlis* (Poaceae: Chloridoideae): support from molecular, morphological, and anatomical characters. Syst. Bot. 33:536–551.

Bess, E.C., A.N. Doust, G. Davidse, y E.A. Kellogg. 2006. *Zuloagaea*, a new genus of Neotropical grass within the "Bristle Clade" (Poaceae: Paniceae). Syst. Bot. 31:656–670.

Chase, M.A. y C.D. Niles (compilers) 1962. Index to grass species. 3 vols. G.K. Hall, Boston.

Clayton, W.D. y S.A. Renvoize. 1986. Genera graminum grasses of the World. Kew Bull. Addit. Ser. 13. Royal Botanic Gardens, Kew.

Davidse, G., M. Sousa S. y A.O. Chater (eds.). 1994. Flora Mesoamericana Vol. 6: 1–543. UNAM, Missouri Bot. Gard. & The Natural History Museum (London).

Dávila, P., M.T. Mejía-Saulés, M. Gómez-Sánchez, J. Valdés-Reyna, J.J. Ortíz, C. Morín, J. Castrejón y A. Ocampo. 2006. Catálogo de las Gramíneas de México. UNAM-CONABIO. México.

Herrera, Y. 2001. Las Gramíneas de Durango. Instituto Politécnico Nacional y Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México.

Herrera Arrieta, Y. 2010. Relación y claves actualizadas de gramíneas de Durango, México. Acta Bot. Mex. En revisión.

Herrera Arrieta, Y y D.S. Pámanes García. 2006. Guía de pastos para el ganadero del Estado de Durango. IPN-COCyTED-Fundacón Produce Durango, A.C.

Herrera-Arrieta, Y. y P.M. Peterson. 2007. *Muhlenbergia* (Poaceae) de Chihuahua, México. Sida, Bot. Misc. 29:1–109.

Herrera Arrieta, Y., P.M. Peterson y A. Cortés Ortiz. 2010. Gramíneas de Zacatecas, México. Sida, Bot. Misc. 32.

Herrera-Arrieta, Y. y A. Cortés-Ortiz. Florística de gramíneas de Chihuahua. IPN CIIDIR Durango. En Proceso.

Finot, V.L., P.M. Peterson, R.J. Soreng y F.O. Zuloaga. 2004. A revision of *Trisetum*, *Peyritschia*, and *Sphenopholis* (Poaceae: Pooideae: Aveninae) in Mexico and Central America. Ann. Missouri Bot. Gard. 91:1–30.

Gentry, H.S. 1957. Los pastizales de Durango, estudio ecológico, fisiográfico y florístico. Traducido por E. Hernández Xolocotzi. Instituto Mexicano de Recursos Naturales Renovables, A.C.

Hitchcock, A.S. y A. Chase. 1951. Manual of the grasses of the United States. 2nd ed. USDA Misc. Publ. 200.

Judziewicz, E.J., R.J. Soreng, G. Davidse, P.M. Peterson, T.S. Filgueiras y F.O. Zuloaga. 2000. Catalogue of New World grasses (Poaceae): I. Subfamilies Anomochlooideae, Bambusoideae, Ehrhartoideae, and Pharoideae. Contr. U.S. Natl. Herb. 39:1–128.

Lawrence, H.M. 1951. Taxonomy of vascular plants. Macmillan Publishing CO., Inc., New York.

McVaugh, R. 1983. Gramineae. In: Anderson, W.R., ed. Flora Novo-Galiciana Vol 14. University of Michigan Press, Ann Arbor.

Mejía-Saulés, M.T. y P. Dávila. 1992. Gramíneas Útiles de México. En: Cuadernos 16. Universidad Nacional Autónoma de México, Instituto de Biología, México, D.F. Pp. 1–298.

Peterson, P.M., R.J. Soreng y Y. Herrera-Arrieta. 2006. *Poa matri-occidentalis* (Poaceae: Pooideae: Poeae: Poinae), a new species from Mexico. Sida 22:905–914.

Peterson, P.M., R.J. Soreng y J. Valdés-Reyna. 2004. *Calamagrostis coahuilensis* and *C. divaricata* (Poaceae: Pooideae: Agrostidinae) two new species from México. Sida 21:311–320.

Peterson, P.M. y J.T. Columbus. 2009. *Muhlenbergia tarahumara* (Poaceae: Chloridoideae: Cynodonteae: Muhlenbergiinae), a new species from Chihuahua, México. J. Bot. Res. Inst. Texas 3:527–534.

Peterson, P.M., R.J. Soreng, G. Davidse, T.S. Filgueiras, F.O. Zuloaga y E.J. Judziewicz. 2001. Catalogue of New World grasses (Poaceae): II. Subfamily Chloridoideae. Contr. U.S. Natl. Herb. 41:1–255.

Rzedowski, J. 1978. Vegetación de México. Editorial Limusa, S.A.

Soreng, R.J., P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras y O. Morrone. 2003. Catalogue of New World grasses (Poaceae): IV. Subfamily Pooideae. Contr. U.S. Natl. Herb. 48:1–730.

Valdés-Reyna, J., F.O. Zuloaga, O. Morrone y L. Aragón. 2009. El género *Panicum* (Poaceae: Panoicoideae) en el noreste de México. Bol. Soc. Bot. Méx. 84:59–82.

Zuloaga, F.O., L.M. Guissani y O. Morrone. 2007. Hopia, a new monotypic genus segregated from *Panicum*. Taxon 56:145–156.

Zuloaga, F.O., O. Morrone, G. Davidse, T.S. Filgueiras, P.M. Peterson, R.J. Soreng y E. Judziewicz. 2003. Catalogue of New World grasses (Poaceae): III. Subfamilies Panicoideae, Aristidoideae, Arundinoideae, and Danthonioideae, Contr. U.S. Natl. Herb. 46:1–662.

MIRANDEA GRISEA (ACANTHACEAE), NEW FOR COAHUILA AND DURANGO, MEXICO

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ABSTRACT

Two new localities are added to the known distribution of *Mirandea grisea*: one in the southwestern Coahuila and other in the northeastern Durango. The distribution of species is thereby significantly expanded almost 200 km northwestward in the Chihuahuan Desert Region.

KEY WORDS: *Mirandea*, Acanthaceae, Chihuahuan Desert

RESUMEN

Dos nuevas localidades se adicionan para la distribución conocida de *Mirandea grisea*: una en el suroeste de Coahuila y otra en el noreste de Durango. La distribución de la especie se expande significativamente hasta casi 200 km al noroeste en la Región del Desierto Chihuahuense.

PALABRAS CLAVE: *Mirandea*, Acanthaceae, Desierto Chihuahuense

The genus *Mirandea* was described by Rzedowski (1959) based on *Mirandea grisea* from San Luis Potosí. At present six species are known in the genus, all of them endemic to Mexico: *Mirandea huastecensis* T.F. Daniel restricted to the Canyon La Huasteca in the state of Nuevo León; *M. hyssopus* (Nees) T.F. Daniel and *M. nutans* (Nees) T.F. Daniel to Querétaro and Hidalgo; *M. sylvatica* Acosta to Chiapas, Oaxaca, Tabasco and Veracruz; and *M. andradenia* T.F. Daniel to Tamaulipas (Daniel 2003; Daniel & Acosta 2003). *Mirandea* species resemble those of *Carlowrightia*, however, they differ in stamen characteristics. In *Mirandea* the filaments are twisted and appressed to the upper lip of the corolla, the anthers open to lower lip, and the style is recurved near the apex, while in *Carlowrightia*, the stamens are not appressed to the upper lip of the corolla, the filaments are not twisted, the anthers open to the upper lip, and the style is straight near the apex (Daniel 1982).

Mirandea grisea has been recorded from San Luis Potosí near El Tepeyac (MEXU, TEX), Matehuala (MICH), Guadalcazar (ENCB, TEX) and El Huizache (ENCB, TEX) (Daniel 1982) and in Tula in southwestern Tamaulipas (CAS, MEXU, MO) (Daniel 1999). Plants occur in scrub vegetation. The new localities are the following:

Voucher specimens: **MÉXICO. Coahuila:** Municipio de Torreón, Sierra de Jimulco, cañón La Gualdria, 1450–1500 m, 10–11 Oct 2008 (fl, fr), *A.E. Estrada 20677* (ANSM, CFNL). **Durango:** Municipio de Lerdo, Sierra El Sarnoso, 25°33'-25° 43' N, 103° 35'-103° 43'W, 1350 m, 24 Aug 1991 (fl), *E. Barajas s.n.* (ANSM).

Distribution and Conservation.—The new records for this species are in the Sierra of Jimulco (ca. 40 km N of Torreón in Coahuila), and in the Sierra El Sarnoso (ca. 10 km W of Sierra de Jimulco, in Durango) (Fig. 1). Vegetation of both areas is desert scrub with *Larrea tridentata, Agave lecheguilla, Parthenium incanum, P. argentatum,*

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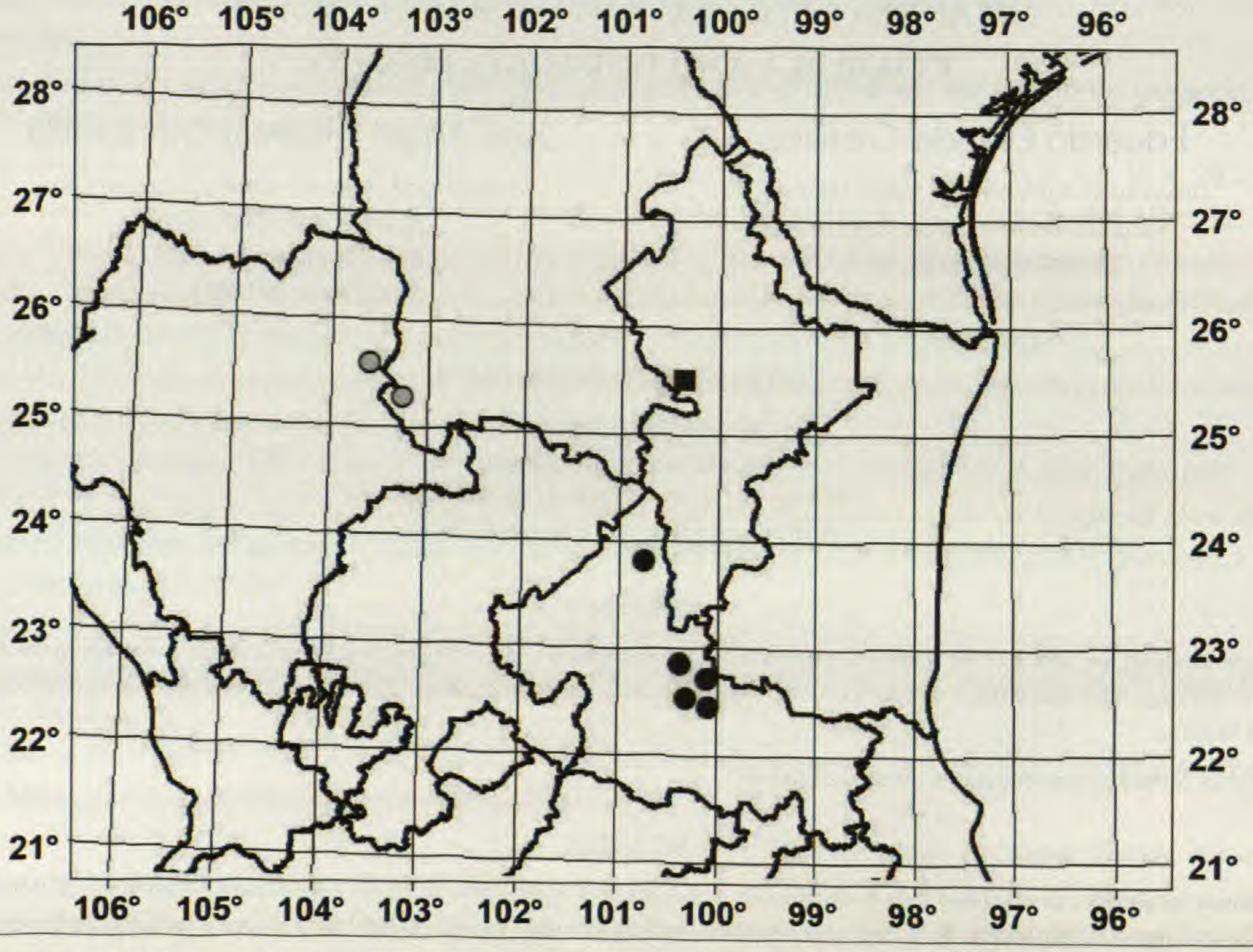

FIG. 1. Distribution of *M. huastecensis* in Nuevo León (black square), and *M. grisea* in San Luis Potosí (black dots), and the new localities of *M. grisea* in SW Coahuila (Sierra de Jimulco) and NE Durango (Sierra El Sarnoso) (gray dots).

Opuntia lindheimeri, *Fouquieria splendens*, *Jatropha dioica*, and *Lippia graveolens* associations. Both localities are almost 300–320 km NW from the nearest locality were *Mirandea grisea* was recorded previously (El Huizache area). In Jimulco as in El Sarnoso, *Mirandea grisea* is rare; it does not form extensive stands as in San Luís Potosí (Daniel 1982). Only a few individuals were located scattered through the vegetation on inclined planes and in the valleys at 1,500 to 1,700 meters. Canopy cover was less than 30%. The new records for this species expand its known distribution almost 200 km northwestward in the Chihuahuan Desert Region. *Mirandea grisea* could be included into the NOM-059-ECOL-2001 (Semarnat 2001) as endangered species in Coahuila and Durango States, since there are only few populations and few individuals in each of these populations.

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REFERENCES

DANIEL, T.F. 1982. The genus *Mirandea* (Acanthaceae). Contr. Univ. Michigan Herb. 15:171–175.

DANIEL, T.F. 1999. Nuevos registros estatales de Acanthaceae en México. Bol. Inst. Bot. (Univ. Guadalajara) 7(1–3):51–59.

DANIEL, T.F. 2003. A new combination in *Mirandea* (Acanthaceae). Acta Bot. Mex. 62:9–13.

DANIEL, T.F. Y S. ACOSTA-C. 2003. Familia Acanthaceae. Flora del Bajío y Regiones Adyacentes. Fascículo 117. Instituto de Ecología, A.C. Pátzcuaro Michoacán.

RZEDOWSKI, J. 1959. Nuevas adiciones a la flora mexicana. Ciencia (México) 19:80.

SERMARNAT. 2001. NOM-059-ECOL-2001 (lista de especies amenazadas, en peligro de extinción y sujetas a protección especial). Diario Oficial de la Federación, México, D.F.

REGISTRO DE DOS NUEVAS LOCALIDADES Y REUBICACIÓN DE INDIVIDUOS DE UNA DE ELLAS DE *ASTROPHYTUM MYRIOSTIGMA* (CACTACEAE) EN DURANGO, MÉXICO

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RESUMEN

Astrophytum myriostigma es una especie endémica extremadamente codiciada y saqueada en las áreas donde se distribuyen. Se encuentra catalogada como Amenazada de extinción y no se habían reportado poblaciones para esta zona del estado de Durango. La especie se distribuye en zonas calcáreas que son utilizadas para aprovechamiento minero extractivo (caliche), por lo que el riesgo de extinción es latente.

ABSTRACT

Astrophytum myriostigma is an endemic species that is highly coveted and collected across its area of distribution. The species is listed as threatened and there are no documented collections or reports of populations in Durango, México. The species is distributed in limestone areas used for extractive mining exploitation (caliche), thus increasing the possibility of extinction.

El Desierto Chihuahuense se caracteriza por su rica diversidad y endemismo de cactáceas (Hernández y Godínez 1994; Hernández y Bárcenas 1995), muchas de las cuales se encuentran en alguna categoría de riesgo (Hernández y Godinez 1994; Hernández y Bárcenas 1995 y 1996; Gómez-Hinostrosa y Hernández 2000; Hernández et al. 2001). Una de las especies catalogada como amenazada de extinción es *Astrophytum myriostigma* Lem. (SEMARANT 2002). Especie distribuida en los estados de Coahuila, Nuevo León, Tamaulipas, San Luís Potosí (Bravo y Sánchez-Mejorada 1991; Guzmán et al. 2003; Henrickson y Johnston 1997) y Durango, habitando pendientes pedregosas, asociado a comunidades de *Agave lecheguilla* y *Hechtia glomerata* (Henrickson y Johnston 1997). Actualmente se reconocen dos variedades de esta especie *Astrophytum myriostigma* var. *myriostigma* y *Astrophytum myriostigma* var. *coahuilense* (Kanfer) Borg, esta última con alto grado de polimorfismo (Henrickson y Johnston 1997), por lo que llega a ser considerada como una sola especie (Guzmán et al. 2003). Es una especie evolutivamente calcícola apomórfica (Del Castillo 1996) y al menos en las localidades del Desierto Chihuahuense donde se ha registrado, se distribuye con rangos altitudinales que van de los 1170 a 1205 msnm, con suelos de tipo calcáreos (Sánchez-Salas 2002). Esta especie no fue reportada para el estado de Durango (Guzmán et al. 2003).

Población de *Astrophytum myriostigma* en la Sierra El Sarnoso

En junio de 2002 se registró una nueva población de este taxa (Fig. 1) en Durango, localizada en la sierra "El Sarnoso" (25°35'N, 103°35'W), dentro del municipio Lerdo, Durango (Sánchez-Salas y Romero 2003). La vegetación en esta área corresponde a matorral rosetófilo, predominando *Agave lechuguilla* Torr., *Opuntia leptocaulis* DC. y *Jatropha dioica* Sessé; esta población es diferente a la reportada por Henrickson y Johnston (1997), localizada el Cerro "La bola" en las montañas cercanas al poblado de Viesca, 350 Km al Noreste de Torreón, Coahuila.

La población de *A. myriostigma* localizada en la sierra "El Sarnoso" abarca una superficie de aproximadamente 7.11 Km^2. Con la finalidad de conocer la densidad de individuos de la población, en Junio de 2002 realizamos un primer muestreo estratificado (Franco 1985) geoposicionando ocho cuadrantes de 10

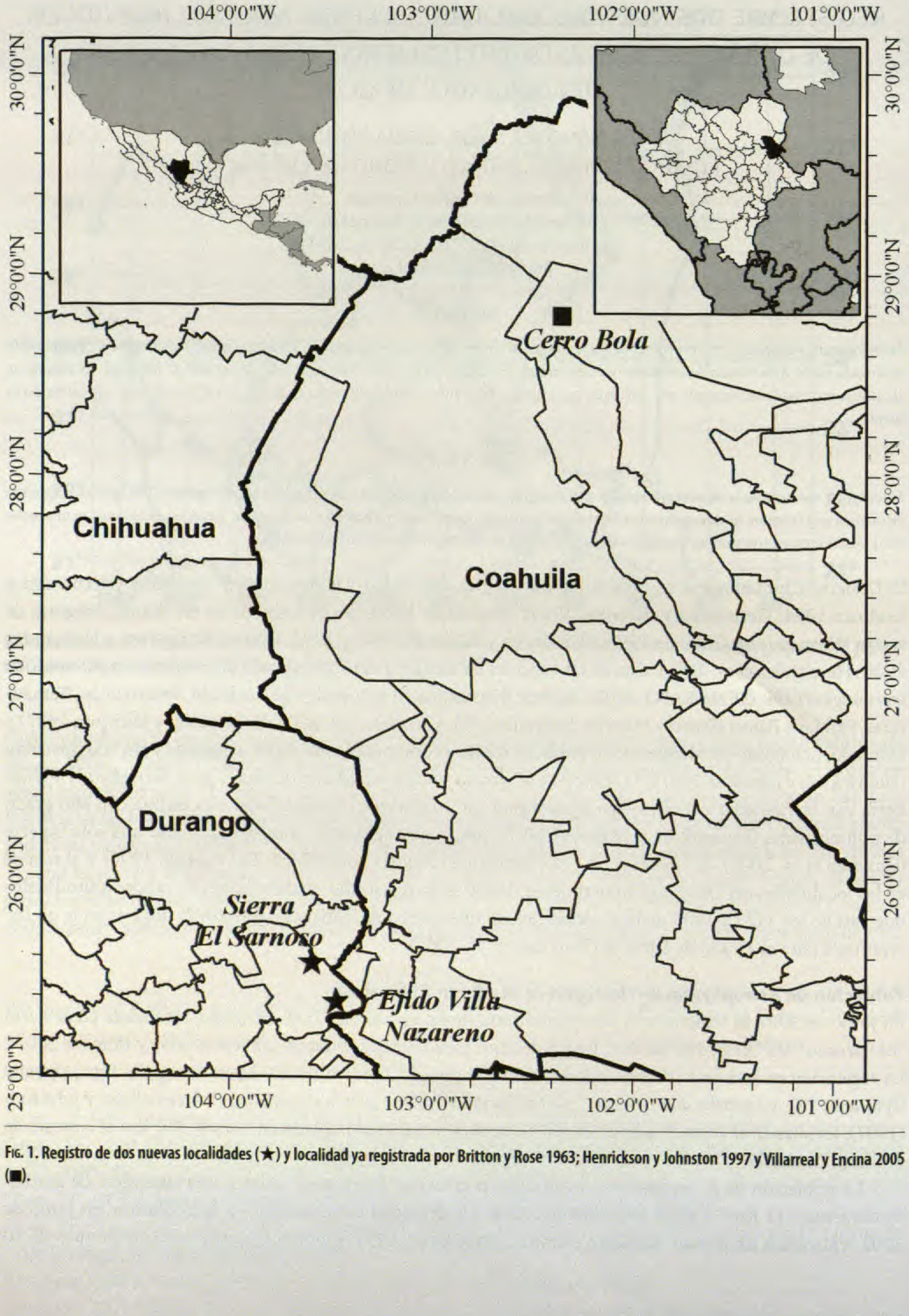

FIG. 1. Registro de dos nuevas localidades (★) y localidad ya registrada por Britton y Rose 1963; Henrickson y Johnston 1997 y Villarreal y Encina 2005 (■).

× 10 m, donde registramos un total de 75 individuos (Muro-Pérez 2002). Posteriormente, en Septiembre del mismo año, se geoposicionaron otros ocho cuadrantes en lugares diferentes dentro de la misma población, esta vez se registraron 27 individuos más, totalizando 102 individuos (Sánchez 2002; Sánchez y Romero 2003). En Octubre de 2006, utilizando la misma metodología, se cuantificaron de nuevo los individuos de *A. myrisotigma* en los mismos16 cuadrantes. En esta ocasión el registro de individuos disminuyó a 92 individuos, 10 individuos menos que en Septiembre de 2002 (registro anterior). Esta disminución fue resultado de la extracción ilegal de las plantas (Muro-Pérez 2006), pues se pudo constatar visualmente los huecos en la tierra que dejan las plantas al ser extraídas.

En Mayo de 2009, se realizó otra cuantificación de individuos de esta especie en los mismos cuadrantes y con la misma metodología, en esta ocasión se registraron únicamente 75 individuos en la población, 35 menos que los registrados en Octubre de 2006. Estas 35 plantas saqueadas, fueron localizadas a 40 m de distancia respecto la población origen de esta especie, en dos costales, con 15 y 20 individuos respectivamente. Desafortunadamente, los individuos extraídos eran individuos adultos, de 35 cm de largo o mayores, reportados como "plantas madre" (Reza 2008), mismos que proveen las semillas que mantienen a la población estable *in situ*, y al ser saqueadas ocasionan una disminución en la producción de nuevos individuos que reemplazarán a los adultos seniles.

La extracción ilegal de esta especie en la zona es llevada a cabo por pobladores de la región, como encargo de traficantes extranjeros que pagan cantidades irrisorias por ejemplares de esta especie (Sánchez-Salas 2002; Muro-Pérez 2002). En el presente año se realizará una nueva cuantificación de individuos, ya que de acuerdo con los pobladores del área, esta zona aún no está exenta de saqueo y comercio ilegal por parte de coleccionistas extranjeros quienes pretenden poseer esta codiciada planta dadas sus peculiaridades morfológicas de gran belleza.

Población de *Astrophytum myriostigma* en el Ejido Villa Nazareno

El Ejido Villa Nazareno (Fig. 1) se localiza en el Municipio Gómez Palacio, Durango, México (25°24'N, 103°25'W), la vegetación en esta zona corresponde a comunidades de matorral rosetófilo, donde las especies predominantes son: *Agave lecheguilla* Torr, *Yucca torreyi* Shafer, *Larrea tridentata* Coville y *Hechtia glomerata* Zucc. En febrero de 2004 registramos la presencia de 3 individuos de esta especie, la población se delimitó geográficamente con geoposicionador para conocer la superficie de distribución, la cual abarca aproximadamente 25 m^2. En octubre de 2004, se geoposicionaron 6 cuadrantes de 10 × 10 m dentro de esta población para cuantificar el número de individuos, en total se cuantificaron 32 plantas de *A. myriostigma*. Adyacente a esta población de individuos, se localiza un área donde actualmente se extrae mineral (caliche) y su área de impacto se expande hacia esta población de *A. myriostigma*. Una semana después, localizamos otra pequeña población de individuos a una distancia de aproximadamente 50 m al E de la primera población y al igual que la población anterior, la delimitamos geográficamente con GPS. Esta abarca una superficie de 250 m^2, donde se establecieron tres cuadrantes de 10 × 10 m para calcular la densidad de individuos en su superficie. En esta población se registraron 10 individuos, en total ambas poblaciones suman 42 individuos.

Para evitar la destrucción de la población y muerte de los individuos de la población adyacente al área de extracción de mineral de caliche, se presentó un programa de rescate de esta especie a SEMARNAT (Secretaría del Medio Ambiente y Recursos Naturales), para remover los 32 individuos de la primera población a la segunda de éstas; concedida la autorización (No. Oficio: SG/130.2.2.1/002193; No. Tramite: 3532), reubicamos los 32 individuos a la segunda población. En la actualidad, los individuos parece se han adaptado bien al sitio donde se reubicaron, pues no ha habido mortandad en ninguno de ellos; seguiremos monitoreando esta población para tratar de seguir protegiendo esta especie en inminente peligro de extinción.

La presencia de las dos poblaciones de *A. myriostigma* registradas para el municipio de Gómez Palacio y Nazareno, Dgo., con una separación entre ellas de 37 km lineales; aunada a la del Cerro Bola cerca de San Pedro de las Colonias (Britton y Rose 1963; Henrickson y Johnston 1997; Villarreal y Encina 2005) en Coahuila (Fig. 1); separadas por 50 km lineales en promedio, respecto a los nuevos registros (Fig. 1); hacen suponer preliminarmente que estas poblaciones se encuentran sujetas a la dispersión llamada "arca de Noé"

de tipo pasiva o activa que se da sobre corredores o filtros geográficos (Brown y Lomolino 1998); por lo que se pudiera considerar que las serranías localizadas en los estado de Durango y Coahuila funcionan como un geosistema dispersor de la especie.

Poblaciones en riesgo de extinción latente

Además de estar asentadas las poblaciones de esta cactácea sobre suelos de explotación minera (calcáreos), lo cual disminuye las poblaciones y de que los individuos de *A. myriostigma* son extraídos continuamente para su uso como plantas de ornato (Sánchez-Salas et al. 2006); otro factor antrópico afecta directamente a la permanencia de esta importante cactácea. Las poblaciones se distribuyen asociadas a comunidades de *Agave lecheguilla* (Henrickson y Johnston 1997), las cuales son utilizadas para la extracción y venta de fibra llamada *ixtle*. Esta agavácea es la principal planta nodriza de *A. myriostigma* (Muro-Pérez et al. 2009), por lo que de desaparecer las comunidades de *A. lecheguilla*, la cactácea *A. myriostigma* se extinguiría junto con ella.

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REFERENCIAS

Alcaraz-Ariza, J.F. 2009. Geobotánica. Tema 2. Biografía. Universidad de Murcia. Murcia, España. P. 3.

Anderson, F.E., Arias, M.S. y P.N. Taylor. 1994. Threatened cacti of Mexico. Succulent Plant Research. Vol. 2. Royal Botanic Gardens, Kew, U.K. P. 8.

Bravo-Hollis, H. y H. Sánchez-Mejorada. 1991. Las Cactáceas de México. Vol. II. Universidad Nacional Autónoma de México, México. Pp. 91–98.

Britton, N.L. and J.N. Rose. 1963. The Cactaceae: descriptions and ilustrations of plantas of the cactus family. Vol. II. Second editions. Dover Publications, New York, NY. U.S.A. Pp. 182–183.

Brown, J.H. y M.V. Lomolino. 1998. Biogeography. Second edition. Sinauer Associates, Sunderland, MA, U.S.A.

Del Castillo, F.R. 1996. Ensayo sobre el fenómeno calcícola-calcífuga en cactáceas mexicanas. Cact. Suc. Mex. 41:3–9.

Franco, L.J. 1985. Manual de ecología. Tema 5. Distribución y estimación del tamaño de la población a partir de la densidad. 2° edición. Editorial Trillas. México, D.F. p. 29–37.

Glass, E.C. 1998. Guía para la identificación de cactáceas amenazadas de México. Vol. 1. CONABIO – CANTE. P. I.

Gómez-Hinostrosa C. y H.M. Hernández. 2000. Diversity, geographic distribution, and conservation of Cactaceae in the Mier y Noriega region, Mexico. Biodivers. & Conservation 9:403–418.

Guzmán, A., S. Arías, y P. Dávila. 2003. Catálogo de Cactáceas Mexicanas. UNAM. Comisión Nacional Para el Conocimiento y Uso de la Biodiversidad (CONABIO). Pp. 198–203.

Henrickson, J. y M.C. Johnston. 1997. A flora of the Chihuahuan Desert Region. Edition 1. 2. Vol. 1. Manuscript. Pp. 255–256

Hernández, H.M, C. Gómez-Hinostrosa, y R.T. Bárcenas. 2001. Diversity, spatial arrangement, and endemism of Cactaceae in the Huizache area, a hot spot in the Chihuahuan Desert. Biodivers. & Conservation 10:1097–1112.

Hernández, H.M y H. Godínez. 1994. Contribución al conocimiento de las cactáceas mexicanas amenazadas. Acta Bot. Mex. 26: 33–52.

Hernández, H.M. y R.T. Bárcenas. 1995. Endangered cacti in the Chihuahuan Desert. I. Distribution patterns. Conservation Biol. 9:1176–1188.

Hernández, H.M. y R.T. Bárcenas. 1996. Endangered cacti in the Chihuahuan Desert. II. Biogeography and conservation. Cons. Biol. 10: 1200–1209. Lista de especies en riesgo. Secretaria de Medio Ambiente y Recursos Naturales. Diario Oficial de la Federación. México, D.F.

Muro-Pérez, G. 2006. Efecto de la altitud y las propiedades del suelo sobre la densidad poblacional de *Astrophytum myriostigma*. Tesis de maestría. Instituto Tecnológico de Torreón (ITT). Pp. 72–74.

Muro-Pérez, G., U. Romero-Méndez, J.D. Flores R. y J. Sánchez-Salas. 2009. Algunos aspectos sobre el nodrizaje en *Astrophytum myriostigma* Lem. (1839) (Cactaceae), en la sierra El Sarnoso, Durango, México. Nakari 20(3):43–48.

Reza-Carrillo, M. 2008. Aspectos demográficos de una población de *Astrophytum myriostigma* Lemaire (1839) Cactaceae en la sierra el Sarnoso, Durango, México. Tesis de Licenciatura. Escuela Superior de Biología. Universidad Juárez del Estado de Durango. P. 37.

Rzedowski, J. 1978. Vegetación de México. Limusa. México, D.F.

Sánchez-Salas, J. y U. Romero-Méndez. 2003. Listado de la flora cactológica de la Sierra El Sarnoso, Durango, México. Nakari 14:27–36.

Sánchez-Salas, J. 2002. Distribución geográfica de la flora cactológica con estatus de conservación, de la sierra el Sarnoso, Durango, Méx. Tesis de licenciatura. Universidad Juárez del Estado de Durango. Escuela Superior de Biología. P. 13.

Sánchez-Salas, J., G.E. Martínez, y R.J. Flores. 2006. Efecto del tamaño de semillas en la germinación de *Astrophytum myriostigma* Lemaire (Cactaceae), especie amenazada de extinción. Interciencia 31(5):371

SEMARNAT. 2002. NORMA Oficial Mexicana NOM-059-ECOL-2001. Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Secretaria de Medio Ambiente y Recursos Naturales. Diario Oficial de la Federación. México, D.F.

Villarreal-Quintanilla, A.J. y A.J. Encina-Domínguez. 2005. Plantas vasculares endémicas de Coahuila y Algunas Áreas Adyacentes. Acta Bot. Mex. 70:1–46.

BOOK REVIEW

EUGENE S. HUNN. 2008. **A Zapotec Natural History: Trees, Herbs, and Flowers, Birds, Beasts, and Bugs in the Life of San Juan Gbëë.** (ISBN 978-0-816-52617-8, hbk.). University of Arizona Press, 355 South Euclid Avenue, Suite 103, Tucson, Arizona 85719, U.S.A., (**Orders:** www.uapress.edu, 1-800-426-3797). $50.00, 262pp., CD-Rom, 11 b&w photos, 6" × 9".

To appreciate fully this work and the field work that went into it, the reader should be interested in the language of the Zapotec people of Oaxaca as well as in their culture and in the botany of the region. While the author enumerates the diversity of animal life, domestic and wild, he concentrates on the inhabitants' relationships with plants. His analyses are not limited to indigenous plants as the Zapotecs use many non-native cultivars in agriculture and in their home flower gardens, which in turn become part of their cultural use in ceremonies and festivals, and more importantly as remedies. As the author explains, the "folk science" of ethnomedical knowledge, plants used for medicinal purposes, is the most interesting of plant-human relationships, and because of that importance, it's one of the reasons that children even at a very young age become acquainted with plants as herbal medicines. His chapters on these subjects are especially thorough and enlightening.

Part 2, the CD-Rom, is strong on language, the Zapotec, Spanish, English, and Latin binomials for the species mentioned in the text.—*Joann Karges, Texas Christian University Library (Retired), Fort Worth, Texas, U.S.A.*

ERIGERON MANCUS (ASTERACEAE) DENSITY AS A BASELINE TO DETECT FUTURE CLIMATE CHANGE IN LA SAL MOUNTAIN HABITATS

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ABSTRACT

The La Sal Daisy, *Erigeron mancus* Rydb., is endemic to timberline and alpine habitats of the La Sal Mountains in Utah, an insular, laccolithic mountain range on the Colorado Plateau in southeastern Utah. It occurs in alpine herbaceous communities from timberline to the crestline of the La Sals. Our primary goal in this study was to measure basic population biology parameters for the *E. mancus* population on the ridge from Mt. Laurel in the Middle Group of the La Sals west to treeline. We measured both *E. mancus* density and vascular plant species composition within 1-m × 1-m square frames along a ridgeline transect in mid-July near peak flowering time. Mean density was 7.09 plants/m^2 which yielded a population estimate of over 200,000 plants along Mt. Laurel ridge and its nearby southern crestline. Density does not appear to change significantly with elevation since the standard errors of the density estimates of the three main patches overlap. The elevation of the sampled *E. mancus* population centroid weighted by *E. mancus* density was 3537 m (12,330 ft) which is within the largest patch near a shallow windswept saddle. Vascular plant diversity along the Mt. Laurel ridge transects averaged 17 ± 0.58 SE species per square meter with a richness range of 10–26 species per square meter. This study provides baseline data on the population biology of *E. mancus* which will then allow future re-measurements of density, population size, and elevational centroid to indicate population trends in response to climate change and anthropogenic stressors.

RESUMEN

La margarita de La Sal, *Erigeron mancus* Rydb., es endémica del límite altitudinal del bosque y hábitats alpinos de las montañas de La Sal en Utah, una cadena de montañas insulares, lacolíticas en la meseta del Colorado en el sureste de Utah. Aparece en comunidades alpinas herbáceas desde el límite altitudinal del bosque hasta las crestas de La Sal. Nuestro objetivo primario en este estudio fue medir los parámetros básicos en biología de poblaciones de la población de *E. mancus* en la cadena del Mt. Laurel en el grupo central del oeste de La Sal hasta el límite del arbolado. Medimos la densidad de *E. mancus* y la composición de especies de plantas vasculares en cuadrados 1-m × 1-m a lo largo de un transecto a mediados de julio cerca del pico de floración. La densidad media fue 7.09 plantas/m^2 que dio una población estimada de más de 200,000 plantas a lo largo de la cadena del Mt. Laurel y su crestería por el sur. La densidad no parece cambiar significativamente con la elevación ya que el error estándar de la densidad estimada en las tres manchas se solapa. La elevación del centroide de la población muestreada de *E. mancus* ponderado con la densidad de *E. mancus* fue 3537 m (12,330 ft) que cae dentro de la mancha mayor cerca de un collado plano barrido por el viento. La diversidad de plantas vasculares en los transectos a lo largo de la cadena del Mt. Laurel dio una media de 17 ± 0.58 SE especies por metro cuadrado con un rango de riqueza de 10–26 especies por metro cuadrado. Este estudio aporta los datos básicos de la biología de la población de *E. mancus* que permitirá en el futuro otras medidas de densidad, tamaño poblacional, y altitud del centroide para indicar las tendencias de la población en respuesta al cambio climático y estrés antropogénico.

INTRODUCTION

The La Sal Daisy, *Erigeron mancus* Rydb., is endemic to timberline and alpine habitats of the La Sal Mountains in Utah, an insular, laccolithic mountain range on the Colorado Plateau in southeastern Utah (Blakey & Ranney 2008). It was listed as a Candidate 2 species under the 1973 Endangered Species Act by the U.S. Fish and Wildlife Service (1993) since sufficient biological data were lacking to determine if Threatened or Endangered status was justified. It is also listed as a G2 species (globally imperiled) under the NatureServe Conservation Status guidelines due to its very restricted range (Utah Native Plant Society 2010). *Erigeron mancus* occurs in alpine herbaceous communities from timberline to the crestline of the La Sal Mountains (Smith 2008) including Mt. Peale Research Natural Area (RNA) which was established specifically to protect ecosystem structure and function in representative alpine and subalpine habitats in the La Sals.

Research natural areas are part of a national network of ecological areas designated in perpetuity for research and education and/or to maintain biological diversity on National Forest System lands (U. S. Forest

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Service 1994). Forest Service objectives for these areas include protection against serious environmental disruptions and serve as baseline areas for measuring long-term ecological changes. No permanent study plots were established in the Mt. Peale RNA prior to our climate change work on *E. mancus.*

Global mean temperature is predicted to rise 1–6° C in the next century due to increased concentration of greenhouse gases (Solomon et al. 2007) and has increased 0.4° C over the previous 150 years (Trenberth et al. 2007). The predicted general response of species to this increased warmth is to migrate north in latitude or up in altitude (Grabherr et al 1994; Theurillat & Guisan 2001; Walther 2002; Root et al. 2003; Kullman 2008; Lenoir et al. 2008) although most ecologists expect species to respond individualistically and not as intact communities (Franklin et al. 1991; Theurillat & Guisan 2001). Alpine species population decline and extinction are also possible since there may be little available habitat for species' upward migration (Chapin & Körner 1994; Grabherr et al 1994; Theurillat & Guisan 2001). These potential ecological changes indicate the need to establish baseline plant species' distributions and abundances at local scales to definitively detect changes (Post et al. 2009). Locally abundant, single mountain endemic species like *E. mancus* offer good opportunities to establish baseline studies for this purpose.

Our primary goal in this study was to measure basic population biology parameters for the *E. mancus* population on the ridge from Mt. Laurel in the Middle Group of the La Sals west to treeline. We estimated plant density and patch size in order to estimate the total number of *E. mancus* plants on this ridge. A secondary goal was to describe vascular plant species composition within the area populated by *E. mancus.* For both of these goals, we were also interested in the influence of elevation within alpine habitats. We addressed these research questions in the context of current and predicted global warming and the need to establish baseline ecological information in order to understand future climate change effects.

METHODS

The study area was in the Middle Group of the La Sal Mountains in San Juan County in southeastern Utah (Fig. 1) on the Manti-La Sal National Forest. The study area was defined as the Mt. Peale Research Natural Area (RNA) and the ridge just west of Mt. Laurel. In June, 2009 we established a 1-km elevational ridgeline transect from timberline to the large talus field at the west base of Mt. Laurel. This included three vegetation patches with gaps for the large talus patches near the USFS pre-Laurel weather station. It covers an elevational range from 3430 m to 3629 m through patches of alpine herbaceous vegetation. We measured both *E. mancus* density and vascular plant species composition within 1-m × 1-m square frames along this transect in mid-July near peak flowering time. Vascular plant species composition was measured at 20-m intervals along the above transect with a random start sampling location within first 20 m and at systematic 20-m intervals thereafter. *Erigeron mancus* density was measured at randomly chosen points along *E. mancus* patch widths at the same 20-m intervals along this transect. In August 2009, we established a 100-m long *E. mancus* density transect along the Middle Group of the La Sals crest line in the saddle just south of Mt. Laurel. Density measurements were taken as above using this transect as a baseline to measure patch widths. Elevational range of this transect was 3632–3642 m. We recorded latitude, longitude, and elevation at each sampling frame with Trimble® Geo XT 2005 Series GPS at sub-meter accuracy using the North American Datum 1983.

Voucher specimens of vascular plant species were collected in June, July, and August. Plants were identified using descriptions and keys published in FNA (1993+) and by comparison with known specimens in the Rocky Mountain Herbarium in Laramie, WY and the USFS Herbarium at RMRS in Flagstaff, AZ. Specimens are deposited at the latter herbarium. Plant nomenclature follows FNA (1993+) and the Intermountain Flora (Cronquist 1972+) in that order of priority. Descriptive statistics for plant densities and species centroid elevations were calculated with SAS/STAT 9.2 (SAS 2008).

RESULTS

Erigeron mancus was confined to dry ridgelines along the elevational transect (Fig. 2). It was not found in large, loose talus areas and tended to sharply decrease in abundance near more mesic areas, especially where

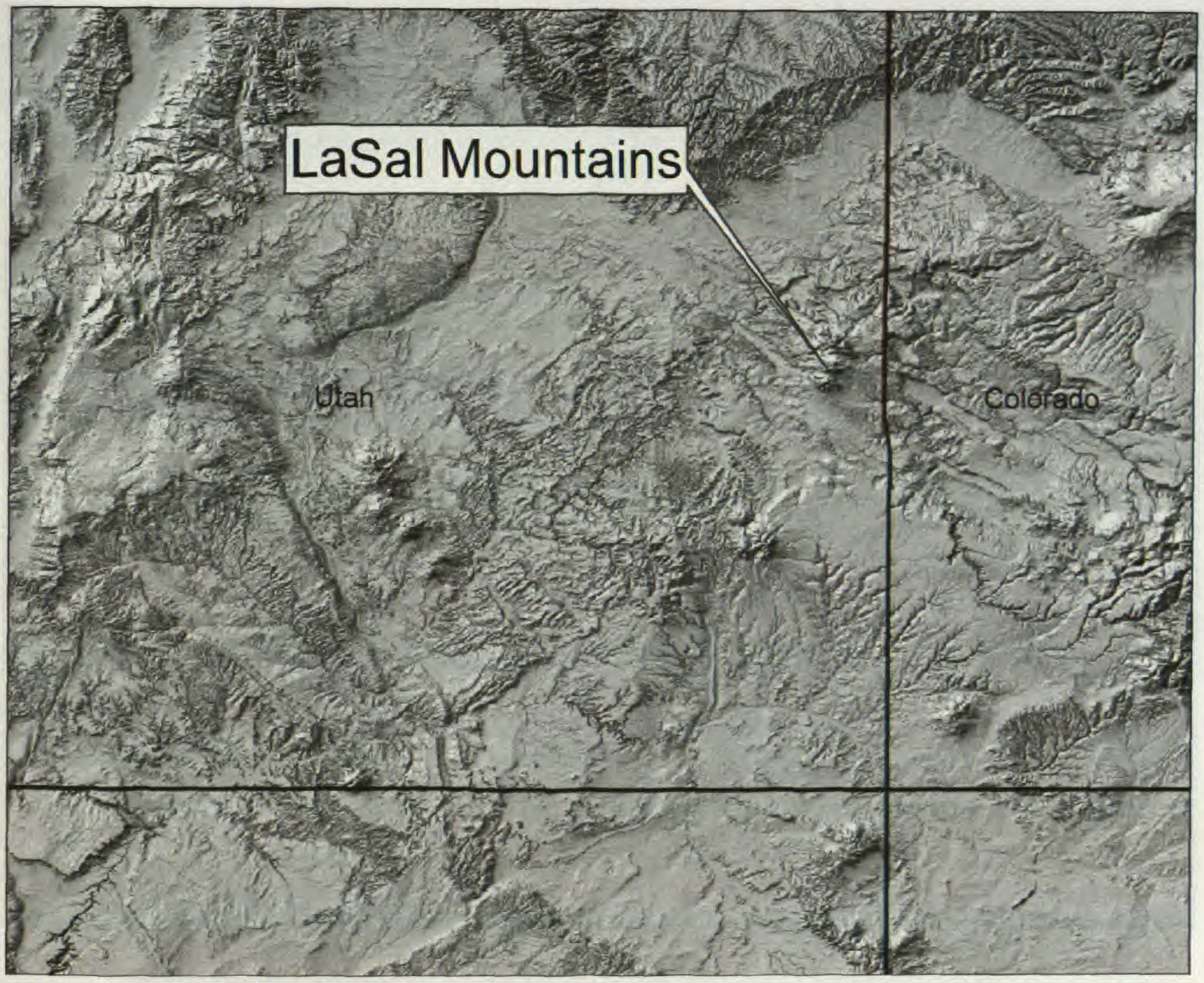

FIG. 1. Location of La Sal Mountains study area in southeast Utah showing the insular nature of the laccolithic uplift.

snow appeared to persist later into the growing season. Plant counts per sampling frame ranged from 0 to 35, reflecting the species' visual patchiness. A range of plant sizes was observed with the smaller ones having a single unbranched caudex and the larger ones having multiple caudex branches. We did not measure plant size or age but some appeared to be relatively young with a small diameter at the top of the caudex while others appeared to be much older with a relatively large diameter caudex and/or a pedicellate caudex due to soil erosion. Mean density was 7.09 plants/m^2 (Table 1) which yielded a population estimate of over 200,000 plants along Mt. Laurel ridge and its nearby southern crestline. Density does not appear to change significantly with elevation since the standard errors of the density estimates of the three main patches overlap (Table 1). The largest *E. mancus* patch size with the largest number of plants is located above and just east of the USFS pre-Laurel weather station (Table 1, Fig. 2).

The elevation of the sampled *E. mancus* population centroid weighted by *E. mancus* density was 3537 m (12,330 ft) which is within the largest patch near a shallow windswept saddle east of the weather station (Fig. 2). We also found a small outlier patch in an open area well within the spruce-fir forest at 3356 m (11,010 ft) and 74 m below the next patch at the timberline start of our sampling transect at 3430 m (11,247 ft). There are additional, unsampled patches of *E. mancus* along the crestline of the Middle Group of the La Sals and at the north base of Mt. Mellenthin.

Vascular plant diversity along the Mt. Laurel ridge transects averaged 17 ± 0.58 SE species per square meter with a richness range of 10–26 species per square meter. We collected one new Utah state record, *Artemisia*

Fig. 2. ***Erigeron mancus*** **sampling points along the west ridge and southern crest line from Mt. Laurel. Mt. Laurel is at 38.455017 N latitude, 109.238257 W longitude. These points were random locations on patch widths measured from the sampling baseline placed along the ridge top. Plant diversity sampling was along this base ridgeline transect.**

Table 1. *Erigeron mancus* population parameters for Mt. Laurel ridge and saddle, Middle Group of the La Sal Mts. Mean ± SE is shown for density and patch width along with number of frames sampled. Elevation of the population/patch centroid is the mean elevation of sampled points, weighted by number of *E. mancus* plants at that point.

Population parameter	Ridge below weather station	Ridge above weather station	Crestline	Total*
Density, # /m^2	6.46 ± 1.73	5.29 ± 1.37	8.90 ± 6.64	7.09 ± 1.30
Patch width, m	12.75 ± 2.09	49.48 ± 8.74	12.55 ± 4.95	27.99 ± 4.42
Transect length, m	467	420	100	1020
Patch size, ha	0.60	2.08	1.26	2.86
Number of frames	24	21	5	52
Elevation of population centroid, m	3491.36 ± 6.94	3552.45 ± 6.34	3638.42 ± 0.71	3537.80 ± 7.62
Estimated population size	38,464	109,935	11,170	202,418

* includes small patch within the scree near the weather station

pattersonii A. Gray. The average number of species gained and lost moving from one sampling point to the next (turnover) along the elevational gradient transect was 13.59 ± 0.77 SE species per sampling point. The turnover rate, calculated as turnover divided by the total species richness of two adjacent frames at 20 m intervals, averaged 56% for this transect. Adjacent sampling frames averaged 10.33 ± 0.44 SE species in common.

TABLE 2. Population centroid elevation (m) for vascular plant species based on frequency of occurrence (not density) within sampling frames along an elevational transect from treeline, 3430 m, to the talus field, 3630 m, at the west base of Mt. Laurel, Middle Group of the La Sal Mountains, Utah. Species are in ascending order of centroid elevation. Species listed had >5 occurrences and were not bimodally distributed along the transect. Mean elevation of all sampling frames, 3525.52 ± 8.04 SE m (n = 47), is indicated by the dashed line below *Carex elynoides*. Frequency of occurrence is based on a total sample size of 47.

Species	Centroid elevation	Frequency of occurrence	Standard error	Minimum	Maximum
Gentiana parryi Engelm.	3452.15	6	5.46	3439	3470
Draba abajoensis Windham & Al-Shehbaz	3455.36	6	6.23	3440	3483
Erigeron grandiflorus Hook.	3457.42	5	8.14	3440	3483
Elymus trachycaulis (Link) Gould	3479.29	15	13.15	3430	3622
Carex rossii Boott	3483.36	7	19.37	3430	3545
Calamagrostis purpurea (Trin.) Trin.	3491.61	8	16.41	3445	3550
Cymopterus lemmonii (J.M. Coult. & Rose) Dorn	3502.24	15	16.77	3438	3629
Achillea millefolium L.	3505.28	25	11.88	3434	3629
Potentilla ovina Macoun ex J.M. Macoun var. *decurrens* (S. Watson) S.L. Welsh & B.C. Johnst.	3513.32	12	20.01	3430	3608
Solidago multiradiata Aiton	3517.02	28	11.43	3430	3622
Noccaea fendleri (A. Gray) Holub	3518.61	20	11.71	3440	3615
Trifolium dasyphyllum Torr. & A. Gray	3520.38	34	10.14	3430	3629
Polemonium viscosum Nutt.	3521.49	21	13.09	3434	3629
Poa abbreviata R. Br.	3522.01	25	10.08	3434	3615
Cerastium arvense L.	3522.45	30	11.12	3434	3629
Carex scirpoidea Michx.	3522.88	18	12.28	3430	3603
Carex elynoides T. Holm	3525.00	32	10.92	3430	3629
Transect mean elevation					
Eremagone fendleri (A. Gray) Ikonnikov	3525.94	40	8.24	3430	3615
Festuca brachyphylla Schult. & Schult.	3527.24	34	8.83	3430	3622
Geum rossii (R. Br.) Ser.	3527.59	40	8.41	3438	3629
Draba aurea Vahl ex Hormem.	3527.89	20	8.01	3470	3584
Hymenoxys grandiflora (Torr. & A. Gray) K.F. Parker	3531.68	16	10.71	3466	3596
Erigeron mancus Rydb.	3531.71	30	8.89	3430	3622
Elymus scribneri (Vasey) M.E. Jones	3534.59	12	6.42	3494	3567
Castilleja sulfurea Rydb.	3539.76	26	10.94	3430	3622
Sedum lanceolatum Torr.	3540.32	11	19.30	3440	3622
Mertensia viridis A. Nels.	3545.53	12	19.34	3440	3629
Artemisia pattersonii A. Gray	3546.69	17	12.84	3455	3622
Potentilla ovina Macoun ex J.M. Macoun var. *ovina*	3548.58	25	8.75	3450	3622
Selaginella densa Rydb.	3549.48	27	9.00	3434	3622
Poa glauca Vahl subsp. *glauca*	3553.62	5	23.67	3481	3622
Minuartia obtusiloba (Rydb.) House	3554.91	21	6.16	3494	3622
Cymopterus bakeri (J.M. Coult. & Rose) M.E. Jones	3556.91	23	9.93	3438	3629
Carex albonigra Mackenzie	3556.95	9	22.51	3455	3622
Androsace chamaejasme Wulfen ex Host	3558.34	18	8.24	3494	3622
Poa glauca Vahl subsp. *rupicola* (Nash) W.A. Weber	3558.37	8	19.36	3434	3615
Trifolium nanum Torr.	3563.56	6	10.10	3530	3591
Silene acaulis (L.) Jacq.	3572.05	8	7.38	3544	3603

For the 38 species encountered along the elevation transect five or more times, the elevation of population centroids were calculated based on occurrence within individual sampling frames then placed in ascending elevation order (Table 2). Most species in the middle part of Table 2 occurred fairly often and ranged over most of the transect's elevation range, 3430–3629 m. *Gentiana parryi, Draba abajoensis, Erigeron grandiflora, Carex rossii,* and *Calamagrostis purpurea* were restricted to the lower part of the elevation range, <3550 m. *Silene acaulis, Trifolium nanum, Androsace chamaejasme, Minuartia obtusiloba,* and *Poa glauca subsp. glauca* were restricted to the upper part of the elevation range, >3481 m. Two species, *Draba aurea* and *Elymus scribneri*, had a relatively narrow elevation ranges, well within the transect elevation range, and centroids with relatively narrow standard errors. The two varieties of *Potentilla ovina* had well separated centroid elevations with non-overlapping standard errors indicating that those centroid elevations are significantly different. However, that is not the case between *Poa glauca* subsp. *glauca* and *Poa glauca* subsp. *rupicola* where the centroid standard errors overlap, thus indicating no significant difference.

DISCUSSION

Prior to this study little was known about the species density of *E. mancus*, however the population along the ridge west of Mt. Laurel appears to be stable. There were dry, windswept areas where *E. mancus* was the dominant plant species as well as other meadow areas with dense forb/graminoid cover in which *E. mancus* was one of many species growing very close together. The similar density estimates for *E. mancus* between the major patches we measured (Table 1) and the observed range of plant sizes and presumable ages would support the hypothesis of a stable population. Similarly, its range from timberline to crest line, including the additional population patches we documented last year (Smith 2008), indicate that it may be quite widespread within the Middle Group of the La Sals. Thus *E. mancus* seems to be persisting under current levels of anthropogenic activity and the current climate pattern. Whether this will remain so under a warming climate is a much more open question.

The population centroid elevation, frequency of occurrence, and elevation range data for the species associated with *E. mancus* shown in Table 2 provide the baseline data for future comparisons. Significant changes in these measures may represent ecological change due to climatic or anthropogenic influences. The elevational data for each species along this transect represent their ecological amplitude along this elevational gradient using raw elevation as a surrogate for temperature, wind, precipitation, and other variables that describe the ecological niche of each species. We now have precise spatial coordinates for multiple occurrences of 38 vascular plant species along this elevational transect which should make detection of impending local extinction possible.

The main rationale for Candidate 2 status species is that sufficient data on biological vulnerability and threat are not currently available to propose listing a species as Threatened or Endangered and that Candidate 2 listing will encourage the necessary research (U.S. Fish and Wildlife Service 1993). They also listed status trend as Unknown for *E. mancus* to indicate that additional survey work is required to determine current trends. This study provides current baseline data on a few aspects of the population biology of *E. mancus* which will then allow future re-measurements of density, population size, and elevational centroids to indicate population trends in response to climate change and anthropogenic stressors.

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REFERENCES

BLAKEY, R. AND W. RANNEY. 2008. Ancient landscapes of the Colorado Plateau. Grand Canyon Association, Grand Canyon, AZ.

CHAPIN, S.F. III AND C. KÖRNER. 1994. Arctic and alpine biodiversity: patterns, causes and ecosystem consequences. Trends Ecol. Evol. 9:45–47.

CRONQUIST, A., A.H. HOLMGREN, N.H. HOLMGREN, AND J.L. REVEAL. 1972+. Intermountain flora, vascular plants of the intermountain west, U. S. A., 6 volumes. The New York Botanical Garden, Bronx.

FLORA NORTH AMERICA EDITORIAL COMMITTEE, EDS. 1993+. Flora on North America north of Mexico 16+ vols. Oxford University Press, New York and Oxford.

FRANKLIN, J.F., F.J. SWANSON, M.E. HAMON, D.A. PERRY, T.A. SPIES, V.H. DALE, A. MCKEE, W.K. FERRELL, J.E. MEANS, S.V. GREGORY, J.D. LATTIN, T.D. SCHOWALTER, AND D. LARSEN. 1991. Effects of global climate change on forests in northwestern North America. Northw. Environm. J. 7:233–254.

GRABHERR, G., M. GOTTFRIED, AND H. PAULI.1994. Climate effects on mountain plants. Nature 369:448.

KULLMAN, L. 2008. Thermophilic tree species reinvade subalpine Sweden - early responses to anomalous late Holocene climate warming. Arctic Antarc. Alpine Res. 40:104–110.

LENIOR, J., J.C. GÉGOUT, P.A. MARQUET, P. DE RUFFRAY, AND H. BRISSE. 2008. A significant upward shift in plant species optimum elevation during the 20th century. Science 320:1768–1770.

NESOM, G.L. 2006. *Erigeron*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Oxford University Press, New York and Oxford. 20:570–602.

POST, E., M.C. FORCHHAMER, M.S. BRET-HARTE, T.V. CALLAGHAN, T.R. CHRISTENSEN, B. ELBERLING, A.D. FOX, O. GILG, D.S. HIK, T.T. HØYE, R.A. IMS, E. JEPPESEN, D.R. KLEIN, J. MADSEN, A.D. MCGUIRE, S. RYSGAARD, D.E. SCHINDLER, I. STIRLING, M.P. TAMSTORF, N.J.C. TYLER, R. VAN DER WAL, J. WELKER, P.A. WOOLEY, N.M. SCHMIDT, AND P. AASTRUP. 2009. Ecological dynamics across the Arctic associated with recent climate change. Science 325:1355–1358.

ROOT, T.L., J.T. PRICE, K.R. HALL, S.H. SCHNIEDER, C. ROSENZWEIG, AND J.A. POUNDS. 2003. Fingerprints of global warming on wild animals and plants. Nature 42:57–60.

SAS/STAT. 2008. SAS/STAT® software, version 9.2 of the SAS System for Windows XP. SAS Institute Inc., Cary, NC.

SMITH, B. 2008. Mt. Peale research natural area alpine vegetation impact assessment. Report to Canyonlands Natural History Association. URL: http://www.cnha.org/discoverypool.cfm?mode=detail&id=1219425572826. Accessed 9 Sep 2010.

SOLOMON, S. (AND 29 OTHERS). 2007. Technical summary. In: Climate change 2007: the physical science basis. Contribution of Working Group I to the fourth assessment report of the Intergovernmental Panel on Climate Change [Solomon, S, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Avery, M. Tignor, and H.L. Miller, eds.]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, U.S.A. Pp. 20–91.

THEURILLAT, J-P. AND A. GUISAN. 2001. Potential impact of climate change on vegetation in the European Alps: a review. Climatic Change 50:77–109.

TRENBERTH, K.E. (AND 11 OTHERS). 2007. Observations: surface and atmospheric climate change. In: Climate Change 2007: The physical science basis. Contribution of Working Group I to the fourth assessment report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Avery, M. Tignor, and H.L. Miller, eds.]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Pp. 235–336.

UNITED STATES FISH AND WILDLIFE SERVICE. 1993. Endangered and threatened wildlife and plants: a review of plant taxa for listing as endangered or threatened species. Fed. Reg. 58: 51144–51190.

UNITED STATES FOREST SERVICE. 1994. Forest service manual 4063 research natural areas. U.S. Department of Agriculture, Forest Service Research, Washington, DC.

UTAH NATIVE PLANT SOCIETY. 2010. Utah rare plants guide. URL: http://www.utahrareplants.org. Accessed 24 May 2010.

WALTHER, G-R., E. POST, P. CONVEY, A. MANZEI, C. PARMESAN, T.J.C. BEEBEE, J-M. FROMENTIN, O. HOEGH-GULDBERG, AND F. BAIRLEIN. 2002. Ecological responses to recent climate change. Nature 416:389–395.

BOOK REVIEW

John S. Wilkins. 2009. **Species: A History of the Idea.** (ISBN: 978-0-520-26085-6, hbk.). University of California Press, 2120 Berkeley Way, Berkeley, California 94704-1012, U.S.A. (**Orders:** www.ucpress.edu). $49.95, 320 pp., 6 ¼" × 9 ¼".

The question "what is a species?" is sure to rile up each and every systematist and taxonomist. It goes much further than labeling and naming organisms to actually understanding and quantifying the units of evolution. Many discussions on species concepts tend to end with little resolution. This sort of topic is not new to science and will surly continue for many years to come as more molecular techniques and new discoveries shuffle up current understanding.

In *Species: A History of the Idea*, John S. Wilkins eloquently presents the evolution of this discussion. He spends not as much time resolving the questions but instead writes of how scientists have addressed the concept (and in some cases, multiple concepts) of what a species is. He calls this essay a "conceptual history of ideas," and as many researchers know, a multitude of separate ideas (in some cases, conflicting ideas) abound in science.

This book is a historical guide of how the view of science has changed with understanding. Wilkins leads us through the classical era of philosophers (Aristotle, Plato, Theophrastus), to the early taxonomists (Linnaeus, Buffon, Lamarck), past Darwin and the "Darwinians," all the way to current species delineations (Dobzhansky, Kevin de Quieroz). In each chapter, Wilkins discusses all of these individuals and their ideas in quite a bit of detail.

Overall, this is an advanced essay that would deeply interest all who delight in conversations about the nature of species, but more importantly, those who want to know the conceptual history of the idea of a species. There is no shortage of important characters that this book lists, from the well known Linnaeus, Darwin, Mayr, and Hennig to the ones that may be less known, such as Marsilio Ficino, Louis Agassiz, and John Ray (not to mention several found later in the book when discussing the "modern debates").

One especially humorous excerpt from the book is towards the end when Wilkins mentions the "species deniers." He addresses the difficulty of paleontological finds and applying a species designation to incomplete fossils. Apparently, taphonomy (the study of how organisms decay and may become fossilized) is very germane to the topic of fossilization. In the supporting foot note, he references a saying that "taphonomists are people who walk along a deserted beach and, on finding a dead fish or jellyfish, will murmur, 'Mmmm, data...'." Similarly interesting anecdotes are found on the author's online blog at evolvingthoughts.net!

This is an intellectually stimulating book specifically for the serious biologists interested in a blend of philosophy, history, and taxonomy.—*Sam Kieschnick, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

SCALLOPLEAF SAGE (*SALVIA VASEYI*: LAMIACEAE) DISCOVERED IN ARIZONA

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ABSTRACT

During the course of field work in Cabeza Prieta National Wildlife Refuge, southwestern Arizona, in 2003, James Cain and Brian Jansen collected *Salvia vaseyi*, previously known only from the western edge of the Sonoran Desert in California and Baja California. Our findings indicate this shrub might be more widespread in southwestern Arizona mountains. *Salvia vaseyi* in Arizona seems to represent a relict population. There are other shrubby *Salvia* in Arizona, but *S. vaseyi* is the most xeric-inhabiting species and has the narrowest ecological and geographical range.

RESUMEN

Durante el desarrollo de trabajo de campo en el refugio nacional de fauna Cabeza Prieta, en el suroeste de Arizona en 2003, James Cain y Brian Jansen recolectaron *Salvia vaseyi*, anteriormente conocida sólo de la zona occidental del Desierto de Sonora y montañas adyacentes de California y Baja California. Nuestros hallazgos indican que este arbusto puede estar más extendido en las montañas del suroeste de Arizona. En Arizona, *S. vaseyi* parece representar una población relicta. Hay otras *Salvias* arbustivas en Arizona, pero *S. vaseyi* es la especie más xérica y presenta los intervalos ecológico y geográfico más restringidos.

INTRODUCTION

On 11 February 2003, JWC and BDJ were collecting and measuring vegetation near the crest (ca. 840 m) of the Sierra Pinta (113.56051°W, 32.29510°N, NAD 83) on the Cabeza Prieta National Wildlife Refuge in southwestern Arizona. These efforts were part of a larger study investigating the ecology of desert bighorn sheep (*Ovis canadensis mexicana*). They encountered a highly aromatic shrub that they could not identify and collected a dried inflorescence and portions of the herbage to be identified by botanists at the University of Arizona Herbarium. The plant was identified by RSF as scallopleaf sage, *Salvia vaseyi* (Porter) Parish (*Audibertia vaseyi* Porter), and represented a new record in Arizona. Cain subsequently collected additional specimens, and in 2010 J. Malusa (School of Natural Resources, University of Arizona, pers. comm.) discovered another population in the nearby Copper Mountains in the Goldwater Military Range (see Broyles et al. 2007 for geographic information). This species was previously known from southeastern California and northernmost Baja California on the western edge of the Sonoran Desert in the Peninsular and eastern Transverse Ranges and adjacent mountains (e.g., Consortium of California Herbaria; Hickman 1993. Fig. 2).

Salvia vaseyi is a highly aromatic shrub or subshrub reaching ca. 1+ m tall (Figs. 1 & 3). It is facultatively drought deciduous and experiences severe dieback in drought. The leaves are thick and highly variable in size, depending on soil moisture, densely pubescent with minute, appressed trichomes, conspicuously glaucous, and the surfaces are often rugulose. The inflorescences are verticillate on usually wand-like, tall flowering stems (Figs. 1 & 3). The calyces, 8–14 mm long, have mostly awned lobes, the awns becoming

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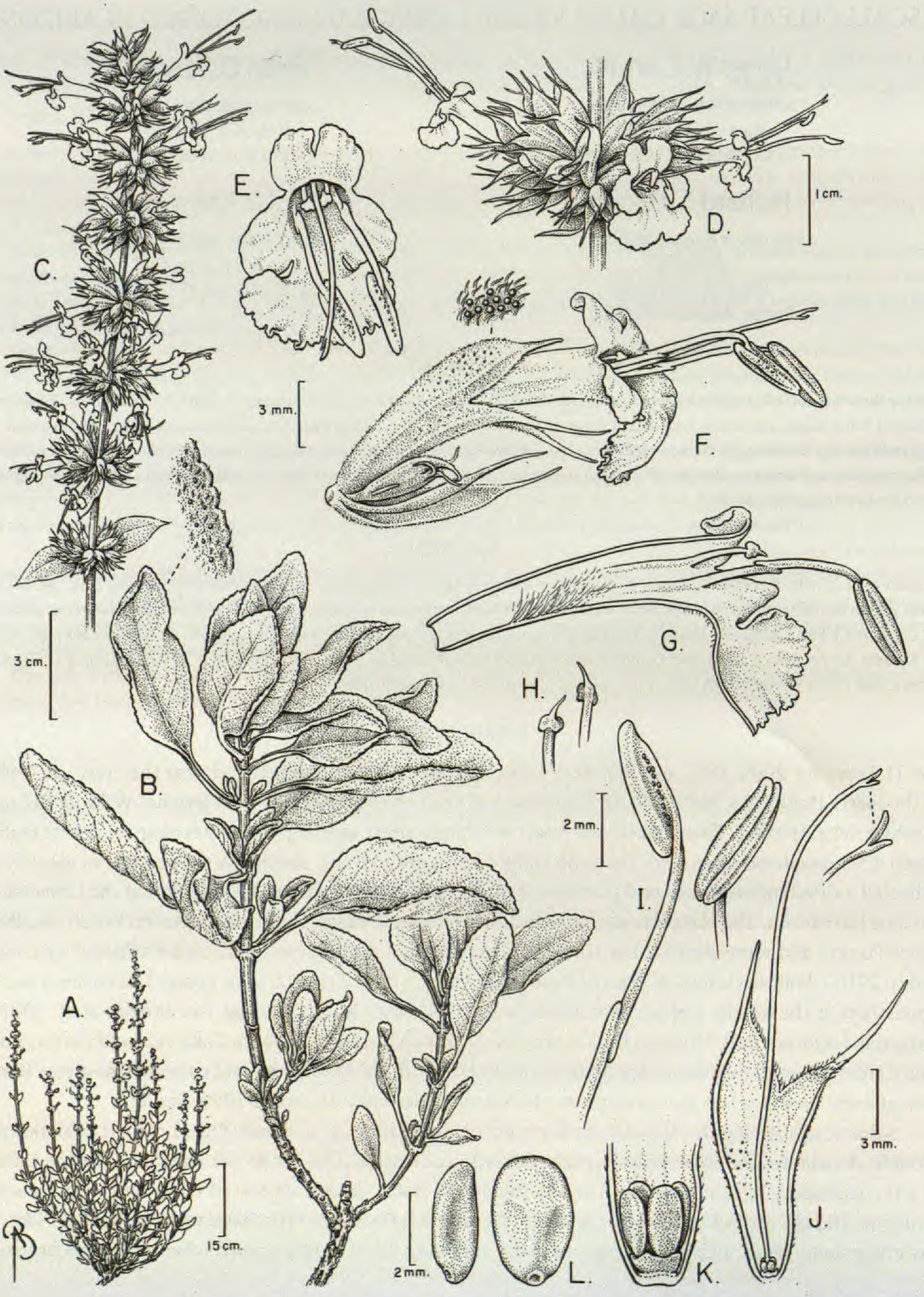

Fig. 1. *Salvia vaseyi*. *Cain & Jansen s.n.*, 11 Feb 2003. Drawing by Bobbi Angel.

Fig. 2. Distribution of *Salvia vaseyi*. California and Baja California localities obtained from the Consortium of California Herbaria (http://ucjeps.berkeley.edu/cgi-bin/get_consort.pl) and the Southwest Environmental Information Network (http://swbiodiversity.org/seinet/collections/index.php); Baja California localities based on specimens cited in text and are approximate. Map by JWC.

spinescent when dry after seed maturity. The corollas, filaments, and styles are pure white, and the corolla tube 13–20 mm long (Figs. 1 & 3). Fruits have light brown nutlets 2.5–3 mm long. The Arizona plants are reproductive at least in spring and likely in fall, depending on rains (soil moisture). We found no morphological differences between Arizona and California specimens.

The Arizona *S. vaseyi* populations occur in vegetation communities characteristic of granitic mountains in the Lower Colorado Valley phytogeographic region of the Sonoran Desert (Shreve 1951; Turner & Brown 1994; Felger et al. 2007). Common plants growing in association with *S. vaseyi* include foothill palo verde (*Parkinsonia microphylla*), brittlebush (*Encelia farinosa*), creosotebush (*Larrea divaricata* var. *tridentata*), desert lavender (*Hyptis emoryi*), white bursage (*Ambrosia dumosa*), rough jointfir (*Ephedra aspera*), range ratany (*Krameria grayi*), desert agave (*Agave deserti*), ocotillo (*Fouquieria splendens*), buckhorn cholla (*Cylindropuntia acanthocarpa*), barrel cactus (*Ferocactus cylindraceus*), saguaro (*Carnegiea gigantea*), and elephant tree (*Bursera microphylla*).

The climate in Yuma County, Arizona, is extremely arid. Rainfall is bimodal and varies widely. The Arizona *S. vaseyi* sites are probably nearly frost-free and probably experience 7.6–10.2 cm (2.86–4.18 in) average annual rainfall based on the nearest long-term weather data from Wellton and Yuma (Western Regional Climate Center 2010). Mean rainfall recorded in the Sierra Pinta (2002–2005) was 1.7 cm in summer (April–August) and 4.9 cm in winter (December–March). High temperatures in summer reached >45°C, and low temperatures in winter reached 2.6°C (JWC, unpublished data).

Salvia vaseyi in the Sierra Pinta was found in 3 local areas, each approximately 60 m in diameter and on steep granitic slopes with southwest exposures. The plants at the summit, at 838 m (2750 ft; *Cain & Jansen 11 Feb 2003*), were common but not abundant. The second site, on the lower slope of the mountain at ca. 405 m (1180 ft; *Cain & Jansen 15 Nov 2003*) and 6 km north of the first locality, had 20–30 *S. vaseyi* plants. The third site, near the base of the mountain (ca. 360 m; *Cain & Jansen 21 Feb 2005*) and 5 km northwest of the

first site, had less than 12 individual plants. On 8 March 2010, J. Malusa found another Arizona population in the Copper Mountains on a north-facing slope about 120 m below the summit. The plants were reported as common at this site. The Copper Mountains are about 28 km west-northwest of the Sierra Pinta (Fig 2).

During extensive fieldwork over several years, JWC and BDJ did not find other *S. vaseyi* plants in the Sierra Pinta or to the west in the ecologically similar Cabeza Prieta Mountains, and J. Malusa reported that he did not find additional plants in the Copper Mountains or similar nearby mountains. Felger and others have conducted extensive fieldwork in other granitic mountains in southwestern Arizona and also have not found other *S. vaseyi* plants. Yet, due to the remote location of many southwestern Arizona mountains and restricted vehicle access due to wilderness designation, there might be other localities where this or other species, previously undocumented in Arizona, occur. *Salvia vaseyi* in Arizona seems to represent a relict population, most likely from a more extensive Ice Age distribution continuous with the Californian populations. Similar Ice Age relict populations, on either side of the Salton Trough are commonplace (e.g., Van Devender 1990, 2007; Felger & Van Devender 2010).

There are approximately 5 shrubby species of *Salvia* in Arizona: *S. dorrii* (Kellogg) Abrams complex (includes *S. pachyphylla* Epling ex Munz), *S. mohavensis* Greene, *S. parryi* A. Gray, *S. pinguifolia* (Fernald) Wooton & Standley, and *S. vaseyi*. Among these, *S. vaseyi* is the most xeric-inhabiting species and has the narrowest ecological and geographic ranges and can be distinguished by its rugulose leaf blades with crenulate margins and bristle-tipped calyx teeth.

Specimens examined: ARIZONA. Yuma Co.: Cabeza Prieta National Wildlife Refuge, Top of Sierra Pinta, ca. 0.5 mi S of Sunday Pass (113.61053W; 32.31704N), ca. 2750 ft, 12–18 inches tall, locally common yamong granite boulders with *Agave deserti, Ambrosia dumosa, Aristida purpurea, Cheilanthes parryi, Ditaxis lanceolata, Ephedra aspera, Eriogonum wrightii, Gymnosperma glutinosum, Heteropogon contortus, Hyptis emoryi, Krameria erecta, Larrea divaricata, Lotus rigidus, Machaeranthera pinnatifida, Mentzelia puberula, Nicotiana obtusifolia, Nolina bigelovii, Parkinsonia microphylla, Physalis crassifolia, Sphaeralcea ambigua, Stephanomeria pauciflora, Tridens muticus, Trixis californica, Bahiopsis parishii*, 11 Feb 2003, *Cain & Jansen s.n.* (ARIZ); Sierra Pinta, ca. 2.6 mi WNW of Sunday Pass, just S of Isla Pinta, 113.61053W, 32.31704N, 1180 ft, associated species: *Ambrosia dumosa, Hyptis emoryi, Ephedra aspera, Cercidium microphyllum, Lotus rigidus, Aristida adscensionis, Opuntia versicolor, Agave deserti*, 15 Nov 2003, *Cain & Jansen s.n.* (ARIZ); Sierra Pinta, ca. 2.7 mi NNW of Sunday Pass, E of Isla Pinta (113.59921W; 32.33719N, 1,330 ft); associated species: *Ambrosia dumosa, Hyptis emoryi, Ephedra aspera, Cercidium microphyllum, Bursera microphylla, Ditaxis lanceolata, Lotus rigidus, Aristida adscensionis, Perityle emoryi, Opuntia versicolor, Agave deserti*, 21 Apr 2005, *Cain s.n.* (ASC, ARIZ, ASU, B, BRIT, CAS, COLO, DAV, DES, F, GH, K, MO, MEXU, MO, NY, RM, RSA, SD, TEX, UC, UCR, UTC, US, USON, Herbarium at Cabeza Prieta National Wildlife Refuge at Ajo, AZ); Barry M. Goldwater Military Range, ¼ mi E of summit of Copper Mountains. UTM S218 700, 3599 669 (WGS 84), 2480 ft, Sonoran desertscrub with *Ephedra aspera, Agave deserti, Bahiopsis parishii, Eriogonum fasciculata, Encelia farinosa, Ziziphus obutusifolia, Lycium exsertum*, etc, 8 Mar 2010, *Malusa s.n.* (ARIZ).

Baja California: summit of grade to Colorado Desert on road from Tia Juana to Mexicali, 14 May 1925, *Peirson 5882* (RSA!); dry slopes, 38 mi W of Mexicali, 2500 ft, 14 May 1925, *Munz 9582* (RSA!); East slope of the Sierra Juarez along Hwy 2, steep slopes with granite boulders and vegetation of *Agave deserti, Salvia* spp., *Haplopappus cuneatus, Thamnosma montana, Eriogonum fasciculatum*, etc, 3000 ft, an uncommon shrub, 25 Apr 1985, *Sanders & Neisess 722* (RSA).

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REFERENCES

Broyles, B., L. Evans, R.S. Felger, and G.P. Nabhan. 2007. Our grand desert: a gazetteer for northwestern Sonora, southwestern Arizona, and northeastern Baja California. In: R.S. Felger and B. Broyles, eds. Dry borders: great Natural Reserves of the Sonoran Desert. University of Utah Press, Salt Lake City. Pp. 581–679.

Consortium of California Herbaria. 2010. http://ucjeps.berkeley.edu/consortium/

Felger, R.S., M. Wilson, K. Mauz, and S. Rutman. 2007. Botanical diversity of southwestern Arizona and northwestern

Fig. 3. A–C. *Salvia vaseyi*. *Cain s.n.*, 21 Apr 2005. Sierra Pinta, Cabeza Prieta National Wildlife Refuge, Arizona, 360 m elev. Photos by JWC. **D.** *Salvia vaseyi*, *Malusa s.n.*, 8 Mar 2010. Copper Mountains, Arizona, 755 m elev. Photo by Jim Malusa.

Sonora. In: R.S. Felger and B. Broyles, eds. Dry borders: great Natural Reserves of the Sonoran Desert. University of Utah Press, Salt Lake City. Pp. 202–271.

Felger, R.S. and T.R. Van Devender. In press. Flora of Tinajas Altas, Arizona—a century of botanical forays and forty thousand years of *Neotoma* chronicles. Proc. San Diego Nat. Hist. Mus.

Hickman, J.C. (ed.). 1993. The Jepson manual. University of California Press, Berkeley.

Shreve, F. 1951. Vegetation of the Sonoran Desert. Carnegie Institution of Washington Publication no. 591. Washington, D.C. Reprinted as vol. I of Shreve & I.L. Wiggins, Vegetation and flora of the Sonoran Desert. Stanford University Press, Stanford.

Southwest Environmental Information Network. 2009. Accessed 20 January 2010 from http://swbiodiversity.org/seinet/index.php.

Turner, R.M. and D.E. Brown. 1994. Sonoran Desertscrub. In: D.E. Brown, ed. Biotic communities of the southwestern United States and northwestern Mexico. University of Utah Press, Salt Lake City. Pp. 181–221.

Van Devender, T.R. 1990. Late Quaternary vegetation and climate of the Sonoran Desert, United States and Mexico. In: J.L. Betancourt, T.R. Van Devender, and P.S. Martin, eds. Packrat middens: the last 40,000 years of biotic change. University of Arizona Press, Tucson. Pp. 134–165.

Van Devender, T.R. 2007. What packrats told us about deep ecology and the ecological detectives who solved the case. In: R.S. Felger and B. Broyles, eds. Dry borders: great Natural Reserves of the Sonoran Desert. University of Utah Press, Salt Lake City. Pp. 58–68.

Western Regional Climate Center. 2010 www.wrcc.dri.edu/CLIMATEDATA.html

PASPALUM PUBIFLORUM AND *P. QUADRIFARIUM* (POACEAE) NEW TO CALIFORNIA, WITH A KEY AND NOTES ON INVASIVE SPECIES

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ABSTRACT

Paspalum pubiflorum and *P. quadrifarium* are reported for the first time for California. New records are also documented for *P. vaginatum*, which is invasive in estuarine wetland habitats. We summarize the current naturalized status, habitats occupied, and regions where recently introduced species of *Paspalum* have been observed or might become invasive in California. We also provide a key to the identification of *Paspalum* species known to occur in the State.

Key Words: California, estuarine wetlands, invasive grasses, nonnative plants, *Paspalum*

RESUMEN

Las especies *Paspalum pubiflorum* y *P. quadrifarium* se reportan por primera vez en California. También se han documentado nuevos registros de *P. vaginatum* que es una especie invasora de los hábitats de humedales estuarinos. Resumimos la situación actual de naturalización, los hábitats ocupados y las regiones donde se ha observado la introducción reciente de especies de *Paspalum* o pudieran convertirse en invasoras en California. También proporcionamos una clave para la identificación de las especies de *Paspalum* que se sabe que ocurren en el estado.

INTRODUCTION

Paspalum L. (Poaceae, Panicoideae) is comprised of approximately 350 species, which are distributed primarily in the subtropical, tropical, and warm-temperate regions of the Americas (Zuloaga & Morrone 2005; Denham et al. 2010). However, owing to their utility as turf, forage or ornamental grasses, many taxa are now widely distributed and have become some of the world's most troublesome weeds (Holm et al. 1979; Weber 2003; GCW 2010; PIER 2010).

The genus *Paspalum*, in general, is easily recognized by its unilateral racemes distributed along the main axis of the inflorescence, plano-convex spikelets with the upper lemma oriented towards the rachis, and the lower glume typically being absent. Confident, species-level determinations, however, often prove difficult. Comparative ecological studies, such as growth responses to salinity and soil saturation, and vegetative morphology, phenology, and habitat associations can improve separation and help explain species distribution (Lakanmi & Okusanya 1990; Rua et al. 2008). Many species of *Paspalum* are also weedy, and since weeds are generally under-collected and thus poorly represented in herbaria, the distribution of many nonnative taxa in North America is poorly known (Allen & Hall 2003). *Paspalum vaginatum* Sw. (seashore paspalum), native to the subtropical and tropical regions of the New World, has been introduced widely and is now naturalized in warm, coastal regions around the world (Allen & Hall 2003; Weber 2003; Zuloaga et al. 2003). Naturalized populations were reported for the first time for California by Riefner and Columbus (2008).

In this paper, we provide the first documented records of *P. pubiflorum* Rupr. ex E. Fourn. and *P. quadrifarium* Lam. for California; *P. pubiflorum* was collected from Orange and western Riverside counties, and *P. quadrifarium* from Los Angeles County in southern California. New records are also documented for *P. vaginatum*, which is invading estuarine and other saline wetlands in southern California. We review the naturalized status, habitats occupied, mode of introduction, and provide a summary of the regions in California where recently introduced species of *Paspalum* have been observed or might become invasive. A key is also provided to identify the known species of *Paspalum* in the State.

NEW RECORDS FOR CALIFORNIA

Paspalum pubiflorum (hairyseed paspalum) and *P. quadrifarium* (tussock paspalum) have not been reported previously for California in treatments of the nonnative Poaceae growing outside of cultivation (Hitchcock 1951; Webster 1993; Bossard et al. 2000, 2006; Hrusa et al. 2002; Allen & Hall 2003; DiTomaso & Healy 2003, 2007; Roberts et al. 2004; Rebman & Simpson 2006; Bossard & Randall 2007; Clarke et al. 2007; Grewell et al. 2007; Riefner & Boyd 2007; Dean et al. 2008; Roberts 2008; Jepson Flora Project 2010; USDA 2010a, b).

Paspalum pubiflorum Rupr. ex E. Fourn.

Voucher specimens: **U.S.A. CALIFORNIA. Orange Co.:** City of Yorba Linda, Santa Ana Canyon, N bank of Santa Ana River, vicinity of La Palma Ave. and Via Lomas De Yorba East, UTM (NAD 83) 11S 043306E 3748143N, elev. ca. 110 m, locally common in mud among rocks and in shallow water, 30 Sep 2007, *Riefner 07-419* (RSA, SI); City of Yorba Linda, Santa Ana Canyon, N bank of Santa Ana River, E of Weir Canyon Rd., vicinity of La Palma Ave. and Mercado del Rio, UTM (NAD 83) 11S 0431111E 3748960N, elev. ca. 107 m, locally common on banks and in shallow water, 2 Dec 2007, *Riefner 07-503* (RSA, SI), same locality, 10 Oct 2009, *Riefner 09-222* (RSA); City of Mission Viejo, Oso Creek, ca. 1.4 mi N of Paseo De Colinas on Camino Capistrano, UTM (NAD 83) 11S 0437526E 3715062N, elev. ca. 88 m, rare, growing with *Paspalum distichum*, small clump in rip-rap rocks and in shallow water near a waste water treatment plant, 11 Nov 2009, *Riefner 09-237* (RSA). **Riverside Co.:** City of Corona, Santa Ana Canyon, Santa Ana River below Prado Dam, ca. 0.5 mi SW of 71 Fwy., UTM (NAD 83) 11S 0438734E 3749611N, elev. ca. 135 m, uncommon, on banks and in shallow water, 10 Oct 2009, *Riefner 09-225* (RSA).

Paspalum pubiflorum is a perennial grass native to the eastern and southwestern United States (Pennsylvania to Texas and Colorado), Mexico, and Cuba (Allen & Hall 2003; Denham et al. 2010; USDA 2010a). In the United States, it grows on moist open ground and disturbed areas, in wet meadows, on banks and edges of forests, streams, ponds, lakes, and irrigation ditches, especially in alkaline or calcareous soils (Hitchcock 1951; Correll & Correll 1975; Allen & Hall 2003).

Paspalum pubiflorum has branched decumbent culms that frequently root at the nodes (Fig. 1a). It has (2–)3–12 racemes per inflorescence with pubescent, rarely glabrescent or glabrous paired spikelets, which are elliptic to obovate-elliptic and (2.4–)2.6–3.2 mm long (Denham et al. 2010). The number of racemes per inflorescence is not a fixed character and varies considerably; Hitchcock (1951) reports 3–5 racemes, and Allen and Hall (2003) report 2–7 racemes per inflorescence. In southern California, populations typically have 3–6 racemes per inflorescence, but it is not uncommon to find plants having 2–3 racemes per inflorescence (Fig. 1b). *Paspalum hartwegianum* E. Fourn. (Hartweg's paspalum) is similar to *P. pubiflorum*. It has simple erect culms with 3–23 racemes (also highly variable) per inflorescence, and paired pubescent spikelets, which are elliptic to obovate and (2.3–)2.6–3.1 mm long (Denham et al. 2010). Accordingly, careful collecting and documentation in the field is needed to accurately separate *P. pubiflorum* from *P. hartwegianum* and other closely related species; currently, *P. hartwegianum* is not known to occur in California.

In southern California, *P. pubiflorum* could be confused with robust forms of *P. distichum* L. (knotgrass), which is a native rhizomatous or stoloniferous perennial with spikelets pubescent only on the back of the upper glumes. Its inflorescence is digitate (with two branches), but a third lower branch may occasionally be present. *Paspalum distichum* is a highly variable species; it can be slender and creeping or robust and cespitose. Although *P. distichum* usually has solitary spikelets, racemes with only paired spikelets or racemes with paired and solitary spikelets can be present on the same plant. Robust forms of *P. distichum* with mostly 3 racemes per inflorescence and paired spikelets collected in southern California have been called *Paspalum*

Fig. 1a. *Paspalum pubiflorum* has branched decumbent culms that frequently root at the nodes. It can form locally dense mats that compete for space with native hydrophytes on stream and river banks. Photograph taken in October, 2008, Santa Ana Canyon, Santa Ana River, Orange County, California.

Fig. 1b. The southern California populations of *Paspalum pubiflorum* may have 2–3 racemes per inflorescence, which could be easily mistaken in the field for *Paspalum distichum*. Photograph taken in July, 2008, Santa Ana Canyon, Santa Ana River, Orange County, California.

paucispicatum Vasey (Hitchcock 1951). *Paspalum paucispicatum* (a synonym of *P. distichum*; Zuloaga et al. 2003) has often been confused with *P. pubiflorum* (Verloove & Reynders 2007a).

Paspalum pubiflorum can be weedy when introduced to new regions (GCW 2009). In southern California, it can form dense mats that compete for space with low-growing native hydrophytes in riverine and urban creek habitats. Although *P. pubiflorum* occupies alkaline habitats, and unlike *P. distichum* and *P. vaginatum*, which are known halophytes (Menzel & Lieth 2003), it is not expected to successfully colonize highly saline estuarine wetlands in southern California.

Paspalum pubiflorum is not utilized for turf, so its occurrence in California is probably the result of an accidental introduction. Its dispersal, invasive behavior, and naturalized distribution require further field study and documentation. Because it can be confused with *P. distichum*, it is likely more widespread than our records indicate.

Paspalum quadrifarium Lam.

Voucher specimen: **U.S.A. CALIFORNIA. Los Angeles Co.:** City of San Dimas, Puddingstone Reservoir, Bonelli Regional Park, East Shore Dr., UTM (NAD 83) 11S 0426136E 3771937N, elev. ca. 285 m, rare, outer flood zone along sunny edge of sandy riparian scrub, 1 Jul 2007, *Riefner 07-288* (RSA, SI).

Paspalum quadrifarium is a large cespitose perennial native to Argentina, Brazil, Paraguay, and Uruguay (Allen & Hall 2003; Zuloaga et al. 2003). In Argentina, *P. quadrifarium* forms dense tussocks in the Flooding Pampa grasslands, on river banks or lake shores, and is often regarded as a weed (Ortega & Laterra 2003; Herrera et al. 2005).

Paspalum quadrifarium is grown as an ornamental in Florida, and has escaped cultivation in the southeastern states (Garbari 1972; Allen & Hall 2003; USDA 2010b). It has been identified as a noxious weed or is a potential invasive pest in New South Wales and Queensland, Australia, coastal Italy, and the southern United States (Allen & Hall 2003; Verloove & Reynders 2007b; Bargeron et al. 2008; Sydney Weeds Committees 2010).

In southern California, *P. quadrifarium* most likely escaped from cultivated sources, and currently is known only from a small population growing in disturbed riparian scrub. Accordingly, this species is here considered tenuously established and its dispersal and naturalization remains to be studied and documented.

Paspalum vaginatum Sw.

Voucher specimens: **U.S.A. CALIFORNIA. Orange Co.:** City of Dana Point, near Ritz-Carlton Hotel, Salt Creek Beach area, UTM (NAD 83) 11S 0432734E 3704750N, elev. ca. 1–2 m, local on the coastal strand, 29 Jul 2008, *Riefner 08-256* (RSA); City of Dana Point, near Ritz-Carlton Hotel, Salt Creek Beach area, UTM (NAD 83) 11S 0432950E 37074260N, elev. sea level, local in wet beach sand within the high tide zone, 29 Jul 2008, *Riefner 08-257* (RSA); City of Irvine, tidal portion of San Diego Creek at Hwy. 73 overpass, UTM (NAD 83) 11S 0420350E 3723837N, elev. ca. 1 m, common and invasive on sandy flats, creek banks, and brackish marsh, 31 Aug 2008, *Riefner 08-267 & Campbell* (RSA); City of Newport Beach, Upper Newport Bay, Delhi Channel near University Dr., UTM (NAD 83) 11S 0418062E 3724031N, elev. sea level, local, muddy banks and flats along tidal channel, 2 Jan 2009, *Riefner 09-10* (RSA). **Riverside Co.:** Sonoran Desert region, Cathedral City, drainage tributary to Whitewater River, Perez Rd. at Date Palm Dr., UTM (NAD 83) 11S 0550217E 3737981N, elev. ca. 82 m, uncommon in wet sand along slow-moving waters of urban creek, 5 Jul 2008, *Riefner 08-215* (RSA). **San Diego Co.:** City of Oceanside, tidal portion of San Luis Rey River at Interstate-5 overpass, UTM (NAD 83) 11S 0464168E 3674334N, elev. ca. 1–2 m, locally invasive on sand flats and in brackish marsh, 15 Sep 2008, *Riefner 08-288* (RSA).

Paspalum vaginatum is known from warm temperate, tropical, and subtropical regions around the world, and is widely regarded as an invasive species; see Erickson and Puttock (2006), ISSG (2008), and Riefner and Columbus (2008) for reviews. Worldwide, and outside of cultivation, *P. vaginatum* occupies coastal salt and brackish water marshes, shallow-water lagoons and tidal channels, mangroves, coastal shrublands, dunes and beaches, summer-moist saltpans, wet pastures, and freshwater riparian and floodplain habitats (Allen & Hall 2003; Shaw & Allen 2003; Weber 2003; Siemens 2006). In southern California, rapidly expanding populations and the formation of dense monocultures of *P. vaginatum* pose a serious threat to the structure, function, and native species composition of estuarine wetlands (Riefner & Columbus 2008).

Paspalum vaginatum, a stoloniferous and rhizomatus perennial, has been used worldwide for the rehabilitation of salt-affected lands, forage, dune stabilization and erosion control, and for turf, including specific ecotypes and cultivars with improved tolerance to saline soils (Carrow & Duncan 1998; Duncan & Carrow 1999; Duncan 2003). *Paspalum vaginatum* cultivars and ecotypes can maintain growth and vigor under irrigation with seawater, i.e., seawater is approximately EC_w (electrical conductivity of water) 54 dS/m^{-1} (deciSiemens per meter) or ~34 ppt (parts per thousand) salt (Duncan & Carrow 1999; Lee et al. 2005; Berndt 2007; Pessarakli 2007). For comparison, freshwater habitats contain <0.5 ppt salt or <1 dS/m^{-1} (Cowardin et al. 1979); the minimum criterion required for a species to be classified as a halophyte is a salinity level having an electrical conductivity measurement of at least 7–8 dS/m^{-1} during significant portions or all of the plant's life cycle (Aronson 1989).

Although we cannot identify specific *P. vaginatum* ecotypes/cultivars that have been introduced to southern California or those growing outside of cultivation in wildlands, high-salinity tolerant plants are now established in tidal wetland habitats, including sea beaches within the high tide zone (Fig. 2a). These ecotypes/cultivars will likely disperse to other seashore habitats in the south coast region, and could possibly establish as far north as central California.

In the coastal lowland wetlands of the Hawaiian Islands, *P. vaginatum* is highly invasive in brackish wetlands (i.e., the mixohaline salinity classification [0.5–30 ppt salt] of Cowardin et al. 1979) (Bantilan-Smith et al. 2009). Although *P. vaginatum* occupies a variety of wetland and saline environments in southern California, including freshwater streams and salt marshes, preliminary salinity analysis indicates that *P. vaginatum* is highly invasive predominately in brackish wetland habitats.

As a result of continuing field documentation, unvegetated sand flats and mudflats located along tidal creeks and lagoons at the head of coastal bays and estuaries appear most vulnerable to colonization by *P. vaginatum* (Fig. 2b). Tidal mudflats are highly productive areas for invertebrates and provide rich foraging habitat for shorebirds at low tide and other birds and fish at high tide (EPA 2010). Worldwide, invasions of *P. vaginatum* are converting unvegetated or sparsely vegetated tidal flats and shallow lagoon habitats to vegetated marshland, which can displace or alter native invertebrate communities, and potentially impact foraging habitat and food resources of shorebirds (Siemens 2006; ISSG 2008; Bird Life International 2009).

Human activities such as dredging and filling have contributed to the loss of tidal mudflats in southern California (Williams & Desmond 2001). Invasions by nonnative species, however, now also pose a threat to estuarine wetland ecosystems (Grewell et al. 2007). Accordingly, development of urban watershed and estuary conservation management plans should include identification and eradication programs to deter the spread of nonnative plants, especially potentially invasive halophytes that could further degrade sensitive estuarine wetlands in southern California.

DISCUSSION

As a result of field work in southern California, and a review of pertinent literature and electronic databases such as the Consortium of California Herbaria (2010), we provide a summary of the distributional records, current naturalized status, occupied habitats, document invasive behavior, and speculate where recently introduced *Paspalum* species might become invasive. These data are summarized in Table 1. Naturalization categories shown in Table 1 are somewhat subjective, but follow Hrusa et al. (2002) in order to allow consistency in data compilation of new introductions for California, which include: naturalized in wildlands (NW); naturalized outside of wildlands, including urban and widlland-urban interface habitats (N); and persistence tenuous (TEN).

Dean et al. (2008) recently pointed out the confusion regarding identifications and the relative naturalized distributions of *Paspalum notatum* Flüggé var. *notatum* versus *P. notatum* var. *saurae* Parodi in California. Considering the ongoing difficulties with separating *P. distichum* from *P. vaginatum*, we provide the following key that will serve to identify the species and varieties of *Paspalum* known to occur in California.

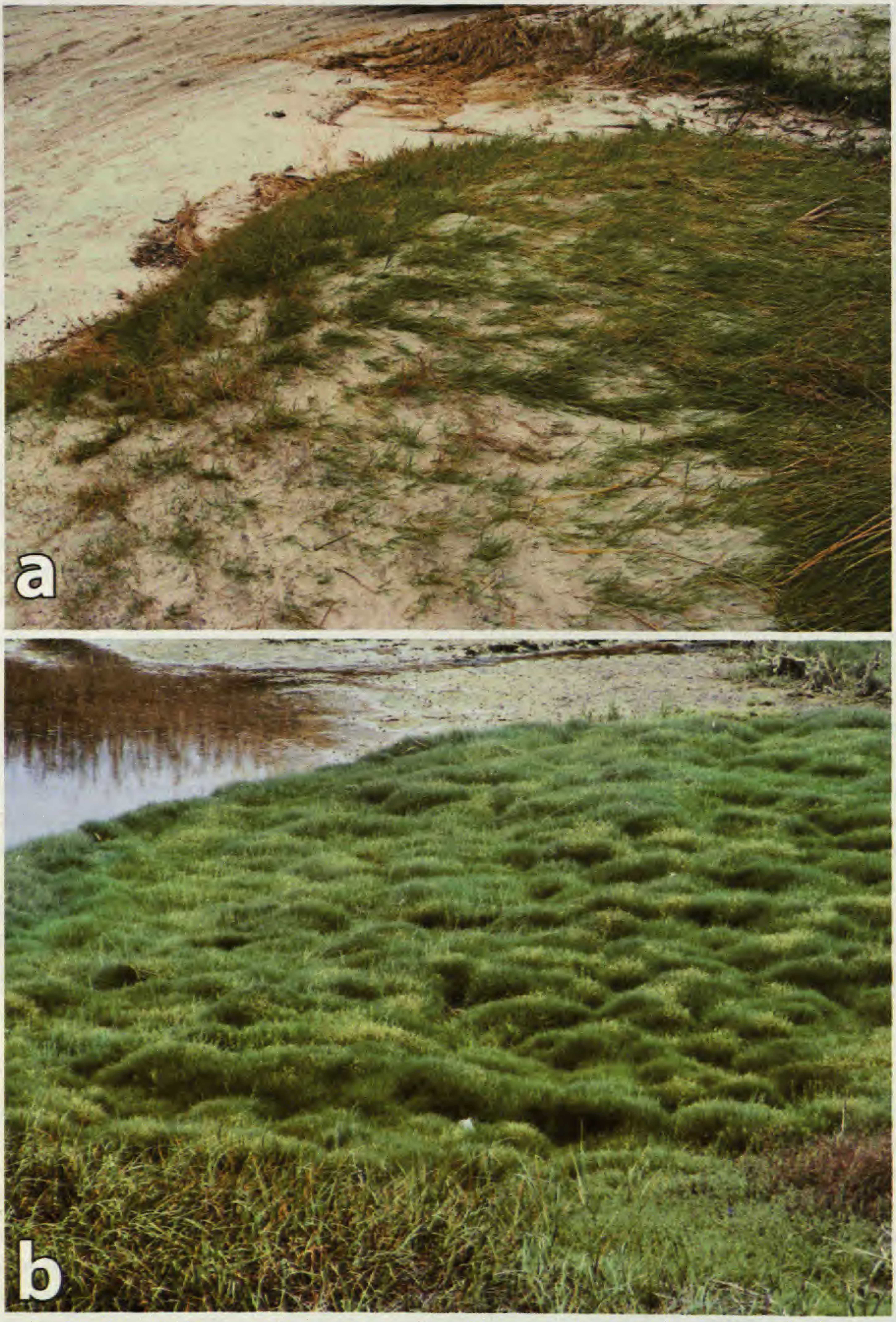

Fig. 2a. View of *Paspalum vaginatum* established on an ocean beach routinely wetted by seawater during high tide events. Photograph taken in August, 2008, Salt Creek Beach, Orange County, California.

Fig. 2b. *Paspalum vaginatum* invasions can convert tidal mudflats to an exotic-plant dominated salt marsh. *Spartina foliosa* is shown in the lower left-hand corner, which typically marks the boundary between vegetated salt marsh and unvegetated mudflat. Photograph taken in June, 2009, along San Diego Creek near its confluence with Upper Newport Bay, Orange County, California.

TABLE 1. Summary of distributional records, current naturalized status, occupied habitats, and observed or potential invasive behavior of three recently introduced *Paspalum* species in California.

Species	Significance in California	Naturalized status and habitats	Invasive behavior
P. pubiflorum	New to State; expected elsewhere in southern and central California	N–urban creek NW–river banks and shallow waters	Possibly alkaline wetlands (not estuarine wetlands) in coastal and mountain foothill regions, less likely in the Sonoran Desert region
P. quadrifarium	New to State; expected elsewhere in coastal southern California, possibly Sonoran Desert region, unlikely elsewhere	TEN–riparian scrub	Possibly riparian habitats in southern coastal regions, especially San Diego Co., and the Sonoran Desert region, unlikely elsewhere
P. vaginatum	Additional records documented for Orange, Riverside, and San Diego counties; first record documented for sea beaches within high tide zone	N–urban creeks NW–freshwater streams and wetlands, tidal creeks and lagoons, brackish and salt marshes, mudflats, coastal strand, and sea beaches	Invasive south coast region, mostly estuarine wetlands, could disperse and establish in central coastal region. Established saline wetlands in the Sonoran Desert region, invasive behavior unlikely along the Salton Sea (salinity >sea water)

A KEY TO *PASPALUM* IN CALIFORNIA

1. Spikelets entirely glabrous, solitary.
   2. Spikelets elliptic-lanceolate, 3–4.5 mm long, plants rhizomatous and stoloniferous, rachis of racemes winged; freshwater to saline wetlands, mostly estuarine habitats ____ **P. vaginatum**
   2. Spikelets broadly elliptic, ovate or obovate, 2.8–4 mm long, plants rhizomatous, rachis of racemes triquetrous to narrowly winged; moist disturbed sites and urban environments ____ **P. notatum**
      3. Spikelets 3.2–4 mm long, blades 0.4–1 cm wide; tetraploids; moist disturbed places, roadsides, turf, fields ____ var. **notatum**
      3. Spikelets 2.8–3.2 mm long, blades 0.2–0.4 cm wide; diploids; disturbed moist urban environments, lawns, gardens, roadsides ____ var. **saurae**
1. Spikelets glabrescent, pubescent, or pilose to ciliate, solitary or paired.
   4. Spikelets mostly solitary, 2.4–3.2 mm long, paired or mixed solitary and paired spikelets may be present, racemes mostly digitate, proliferating racemes may be present, upper glumes sparsely to short pubescent on back; moist to wet disturbed sites, freshwater or brackish marshes, occasionally tidal wetlands ____ **P. distichum**
   4. Spikelets paired.
      5. Inflorescence usually with 10 or more racemes present, the racemes decreasing in length towards the apex.
         6. Spikelets 1.5–3 mm long, margins of upper glumes and lower lemmas pilose to ciliate, glumes long pubescent, 10–20 (30) racemes per inflorescence; plants cespitose, tufted, with short crowded rhizomes; disturbed moist places, ditches, fields, gardens ____ **P. urvillei**
         6. Spikelets 2–2.5 mm long, margins of upper glumes and lower lemmas entire, upper glumes pubescent, lower lemmas glabrous or pubescent, 5–32 (44) racemes per inflorescence; plants cespitose, tussock-forming, generally lacking rhizomes; disturbed riparian scrub ____ **P. quadrifarium**
      5. Inflorescence usually with 2–7 racemes present, each raceme about the same length.
         7. Spikelets 2.3–4 mm long, elliptic, margins of upper glumes and lower lemmas pilose to ciliate, surfaces sparsely pilose; plants cespitose with short rhizomes; moist disturbed sites, urban environments, occasionally wetland and riparian habitats ____ **P. dilatatum**
         7. Spikelets 2.4–3.2 mm long, elliptic to obovate-elliptic, margins and surface of upper glumes and lower lemmas pubescent, rarely glabrescent or glabrous; plants decumbent, rooting at the nodes; disturbed creek and river banks, and shallow water habitats ____ **P. pubiflorum**

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REFERENCES

Allen, C.M. and D.W. Hall. 2003. *Paspalum*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico, vol. 25, Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Oxford University Press, New York, NY. Pp. 566–599.

Aronson, J.A. 1989. Haloph: a data base of salt tolerant plants of the world. Office of Arid Land Studies, University of Arizona, Tucson.

Bargeron, C.T., C.R. Minteer, C.W. Evans, D.J. Moorhead, G.K. Douce, and R.C. Reardon (technical coordinators). 2008. Invasive plants of the United States: identification, biology and control (DVD-ROM). USDA Forest Service Technology Enterprise Team, FHTET-08-11. Morgantown, WV.

Bantilan-Smith, M., G.L. Bruland, R.A. MacKenzie, A.R. Henry, and C.R. Ryder. 2009. A comparison of the vegetation and soils of natural, restored, and created coastal lowland wetlands in Hawaii. Wetlands 29:1023–1035.

Berndt, W.L. Salinity affects quality parameters of 'SeaDwarf' seashore paspalum. HortScience 42:417–420.

Bird Life International. 2009. Important bird area factsheet: Rietvlei Wetland Reserve, South Africa. Available: http://www.birdlife.org/datazone/sites/index.html?action=SitHTMDetails.asp&sid=7165&m=0 [accessed January 2010].

Bossard, C., M. Brooks, J.M. DiTomaso, J.M. Randall, C. Roye, J. Sigg, A. Stanton, and P. Warner. 2006. California invasive plant inventory. California Invasive Plant Council, Publ. No. 2006-02, Berkeley.

Bossard, C.C., J.M. Randall, and M.C. Hoshovesky. 2000. Invasive plants of California's wildlands. University of California Press, Berkeley.

Carrow, R.N. and R.R. Duncan. 1998. Salt-affected turfgrass sites: assessment and management. Ann Arbor Press, Chelsea, MI.

Clarke, O.F., D. Svehla, G. Ballmer, and A. Montalvo. 2007. Flora of the Santa Ana River and environs. Heyday Books, Berkeley.

Consortium of California Herbaria. 2010. *Paspalum*. Available: http://ucjeps.berkeley.edu/consortium/ [accessed May–June 2010].

Correll, D.S. and H.B. Correll. 1975. Aquatic and wetland plants of southwestern United States, vol.1. Stanford University Press, Stanford, CA.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Office of Biological Services, FWS/OBC-79/31, Washington, D.C.

Dean, E., F. Hrusa, G. Leppig, A. Sanders, and B. Ertter. 2008. Catalogue of nonnative vascular plants occurring spontaneously in California beyond those addressed in The Jepson Manual–Part II. Madroño 55:93–112.

Denham, S.S., O. Morrone, and F.O. Zuloaga. 2010. Estudios en el género *Paspalum* (Poaceae, Panicoideae, Paniceae): *Paspalum denticulatum* y especies afines. Annals of the Missouri Botanical Garden 97:11–33.

DiTomaso, J.M. and E.A. Healy. 2003. Aquatic and riparian weeds of the West. U.C. Agriculture and Natural Resources Publication 3421, Oakland, CA.

DiTomaso, J.M. and E.A. Healy. 2007. Weeds of California and other western states, vol. 2, Geraniaceae–Zygophyllaceae. U.C. Agriculture and Natural Resources Publication 3488, Oakland, CA.

Duncan, R.R. and R.N. Carrow. 1999. Seashore paspalum: the environmental turfgrass. John Wiley & Sons, Inc., Hoboken, NJ.

Duncan, R.R. 2003. Seashore paspalum (*Paspalum vaginatum* Swartz). In: M.D. Casler and R.R. Duncan, eds. Turfgrass biology, genetics, and breeding. John Wiley & Sons, Hoboken, NJ. Pp. 295–307.

Erickson, T. and C. Puttock. 2006. Hawaii wetlands field guide: an ecological and identification guide to wetlands and wetland plants of the Hawaiian Islands. Bess Press Books, Honolulu, HI.

Garbari, F. 1972. Il genere *Paspalum* L. (Gramineae) in Italia. Atti Soc. Tosc. Sc. Nat. Mem., Ser. B, 79:52–65.

Global Compendium of Weeds (GCW). 2010. *Paspalum* (Poaceae). Available: http://www.hear.org/gcw/scientificnames/scinamep.htm [accessed January 2010].

Grewell, B.J., J.C. Callaway, and W.R. Ferren, Jr. 2007. Estuarine wetlands. In: M.G. Barbour, T. Keeler-Wolf, and A.A. Schoenherr, eds. Terrestrial vegetation of California, ed. 3. University of California Press, Berkeley, Los Angeles, London. Pp. 124–154.

Herrera, L.P., V.G. Hermida, G.A. Martínez, P. Laterra, and N. Maceira. 2005. Remote sensing assessment of *Paspalum quadrifarium* grasslands in the Flooding Pampa, Argentina. Rangeland Ecol. Mange. 58:406–412.

Hitchcock, A.S. 1951. Manual of the grasses of the United States, ed. 2, revised A. Chase. Dover Publications, Inc., NY.

Holm, L., J.V. Pancho, J.P. Herberger, and D.L. Plucknett. 1979. A geographical atlas of world weeds. John Wiley & Sons, New York (Wiley Interscience Publ.).

Hrusa, F., B. Ertter, A. Sanders, G. Leppig, and E. Dean. 2002. Catalogue of non-native vascular plants occurring spontaneously in California beyond those addressed in The Jepson Manual–Part I. Madroño 46:61–98.

Invasive Species Specialist Group (ISSG). 2008. Ecology of *Paspalum vaginatum*. Available: http://www.issg.org/database/species/ecology.asp?si=1351&fr=1&sts=&lang=EN [accessed January 2010].

Jepson Flora Project. 2010. Index to taxa recorded from California since The Jepson Manual (range extensions from outside California and new naturalizations). Available: http://ucjeps.berkeley.edu/interchange/I_index_newrange.html [accessed May 2010].

Lakanmi, O.O. and O.T. Okusanya. 1990. Comparative ecological studies of *Paspalum vaginatum* and *Paspalum orbiculare* in Nigeria. J. Tropical Ecology 6:103–114.

Lee G., R.N. Carrow, and R.R. Duncan. 2005. Criteria for assessing salinity tolerance of the halophytic turfgrass seashore paspalum. Crop Sci. 45:251–258.

Menzel, U. and H. Lieth. 2003. Halophyte database version 2.0. In: H. Lieth and M. Mochtchenko, eds. Cash crop halophytes: recent studies. Kluwer Academic Publishers, Dordrecht. Pp. 221–250.

Ortega, E. and P. Laterra. 2003. Fire-induced colonization of a Flooding Pampa grassland by thistles: remnant litter and interference effects. Appl. Veg. Sci. 6:35–44.

Pacific Island Ecosystems at Risk (PIER). 2010. Plant threats to Pacific ecosystems, *Paspalum* (Poaceae). Institute of Pacific Islands Forestry. Available: http://www.hear.org/pier/ [accessed January 2010].

Pessarakli, M. (ed.). 2007. Handbook of turfgrass management and physiology. CRC Press/Taylor & Francis Group, Boca Raton, FL.

Rebman, J.P. and M.G. Simpson. 2006. Checklist of the vascular plants of San Diego County, ed. 4. San Diego Natural History Museum, San Diego, CA.

Riefner, R.E., Jr. and J.T. Columbus. 2008. *Paspalum vaginatum* (Poaceae), a new threat to wetland diversity in southern California. J. Bot. Res. Inst. Texas 2:743–759.

Riefner, R.E., Jr. and S. Boyd. 2007. New records of wetland and riparian plants in southern California, with recommendations and additions to the National List of plant species that occur in wetlands. J. Bot. Res. Inst. Texas 1:709–730.

Roberts, F.M., Jr. 2008. The vascular plants of Orange County, California: an annotated checklist. F.M. Roberts Publications, San Luis Rey, CA.

Roberts, F.M., Jr., S.D. White, A. C. Sanders, D.E. Bramlet, and S. Boyd. 2004. The vascular plants of western Riverside County, California: an annotated checklist. F.M. Roberts Publications, San Luis Rey, CA.

Rua, G.H., J.F.M. Valls, D. Graciano-Ribeiro, and R.C. Olivera. 2008. Four new species of *Paspalum* (Poaceae, Paniceae) from Central Brazil, and resurrection of an old one. Syst. Bot. 33:267–276.

Shaw, W.B. and R.B. Allen. 2003. Ecological impacts of sea couch and saltwater paspalum in Bay of Plenty estuaries. DOC Science Internal Series 113. Department of Conservation, Wellington, NZ.

Siemens, T.J. 2006. Impacts of the invasive grass saltwater paspalum (*Paspalum vaginatum*) on aquatic communities of coastal wetlands on the Galápagos Islands, Ecuador. Master of Science Thesis, Cornell University, Ithaca, NY.

Sydney Weeds Committees. 2010. Noxious weeds. Available: http://www.sydneyweeds.org.au/noxious-weeds.php [accessed January 2010].

United States Department of Agriculture (USDA). 2010a. PLANTS database: plants profile for *Paspalum pubiflorum* Rupr. ex E. Fourn., hairyseed paspalum. United States Department of Agriculture, Natural Resources Conservation District. Available: http://plants.usda.gov/java/profile?symbol=PAPU5 [accessed January 2010].

United States Department of Agriculture (USDA). 2010b. PLANTS database: plants profile for *Paspalum quadrifarium* Lam., tussock paspalum. United States Department of Agriculture, Natural Resources Conservation District. Available: http://plants.usda.gov/java/profile?symbol=PAQU6 [accessed January 2010].

United States Environmental Protection Agency (EPA). 2010. Wetlands of the Pacific Southwest: mudflats. Available: http://www.epa.gov/region09/water/wetlands/mudflats.html [accessed January 2010].

Verloove, F. and M. Reynders. 2007a. Studies in the genus *Paspalum* (Paniceae, Poaceae) in Europe–1. *Paspalum distichum* subsp. *paucispicatum*, an overlooked taxon in France. Willdenowia 37:199–204.

Verloove, F. and M. Reynders. 2007b. Studies in the genus *Paspalum* (Paniceae, Poaceae) in Europe–2. the *Quadrifaria* group. Willdenowia 37:423–430.

Weber, E. 2003. Invasive plants of the World. CABI Publishing, CAB International, Wallingford, UK.

Webster, R. 1993. *Paspalum*. In: J.C. Hickman, ed. The Jepson manual: higher plants of California. University of California Press, Berkeley. P. 1280.

Williams, G.D. and J.S. Desmond. 2001. Restoring assemblages of invertebrates and fishes. In: J.B. Zedler, ed. Handbook for restoring tidal wetlands. CRC Press, Boca Raton, London, New York, Washington, D.C. Pp. 235–269.

Zuloaga, F.O. and O. Morrone. 2005. Revisión de las especies de *Paspalum* para América del Sur austral (Argentina, Bolivia, sur Del Brasil, Chile, Paraguay y Uruguay). Monogr. Syst. Bot. Missouri Bot. Gard. 102:1–297.

Zuloaga, F.O., O. Morrone, G. Davidse, T.S. Filgueiras, P.M. Peterson, R.J. Soreng, and E.J. Judziewicz. 2003. Catalogue of New World grasses (Poaceae): III. Subfamilies Panicoideae, Aristidoideae, Arundinoideae, and Danthonioideae. Contr. U.S. Natl. Herb. 46:1–662.

SARRACENIA MINOR VAR. *OKEFENOKEENSIS* (SARRACENIACEAE) DISCOVERED OUTSIDE OF THE OKEFENOKEE SWAMP AREA

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ABSTRACT

A population of *Sarracenia minor* var. *okefenokeensis* is reported from Kings Bay, a 1390 ha basin swamp 30 km northeast of the Okefenokee Swamp in southeast Georgia. This is the first documented account of the variety in a landform other than the Okefenokee Swamp.

RESUMEN

Se cita una población de *Sarracenia minor* var. *okefenokeensis* de Kings Bay, una cuenca pantanosa de 1390 ha situada 30 km al noreste de Okefenokee Swamp en el sureste de Georgia. Esta es la primera población documentada de la variedad fuera de Okefenokee Swamp.

Sarracenia minor Walt. var. *okefenokeensis* Schnell (Okefenokee Giant) was first recognized as a new variety of *Sarracenia minor* in 2002 and is currently defined as endemic to the Okefenokee Swamp area in southeast Georgia (Schnell 2002; Weakley 2010). The Okefenokee variety differs from *S. minor* var. *minor* in morphology, habitat requirements, and flowering time (Schnell 2002; NatureServe 2010). Individuals of *S. minor* var. *okefenokeensis* are generally much taller than *S. minor* var. *minor*, averaging 70–90 cm in height (vs. 25–35 cm in var. *minor*) and have a more slender appearance. Furthermore, *S. minor* var. *okefenokeensis* flower about two weeks later at the same latitude and prefer a much wetter habitat. These differences are maintained in a common garden (Schnell 2002).

Sarracenia minor var. *okefenokeensis* has been designated by NatureServe as G4T2T3 (Globally Imperiled) and has a state rarity rank of S2S3 (Imperiled) in Georgia (NatureServe 2010). Previous work has suggested that populations may be found from 5 km (Schnell 2002) to 8 km (NatureServe 2010) outside the borders of the Okefenokee National Wildlife Refuge (NWR). Unlike the protected populations that exist within the borders of Okefenokee NWR, populations in surrounding areas may suffer from a variety of different anthropogenic threats (NatureServe 2010). Also, there is a lack of population locality information.

The novel occurrence reported here was found 30 km northeast of the Okefenokee Swamp border across the Satilla River (Fig. 1), though in a basin swamp environment similar to those within the Okefenokee. A population of *S. minor* var. *okefenokeensis* was found in Kings Bay, a 1390 ha peat-filled nonriverine basin swamp that stretches 13 km from southeast Brantley County to northwest Camden County (not to be confused with Kings Bay Naval Base in Camden County). Kings Bay exists on a Pleistocene barrier island and was probably a large marshy tidal lagoon in ancient times. Currently, Kings Bay and the Okefenokee Swamp are not connected and it is uncertain whether they were joined in previous times. Thousands of *S. minor* var. *okefenokeensis* individuals were found on floating Peatmoss (*Sphagnum* spp.) mats with *Woodwardia virginica*, *Peltandra sagittifolia*, *Nymphaea odorata* ssp. *odorata*, *Lachnanthes caroliniana*, *Xyris fimbriata*, *Rhynchospora distans*, and *Utricularia subulata*. The Peatmoss mats were floating over approximately 0.5–1 m of water. Plants were also found on scattered hummocks with shrubs of *Lyonia lucida* covered with *Smilax laurifolia*. Small trees of *Pinus elliottii* var. *elliottii*, *Taxodium ascendens*, and *Gordonia lasianthus* were widely spaced throughout the community.

Voucher specimen: **GEORGIA. Brantley Co.:** Kings Bay, S of Kings Bay Rd., 4 km NW of the Kings Bay Rd and Hwy 110 intersection, 81°50'20.431"W 31°8'24.884"N, 10 Jun 2010, *Thompson 1* (VSC)

J. Bot. Res. Inst. Texas 4(2): 771 – 773. 2010

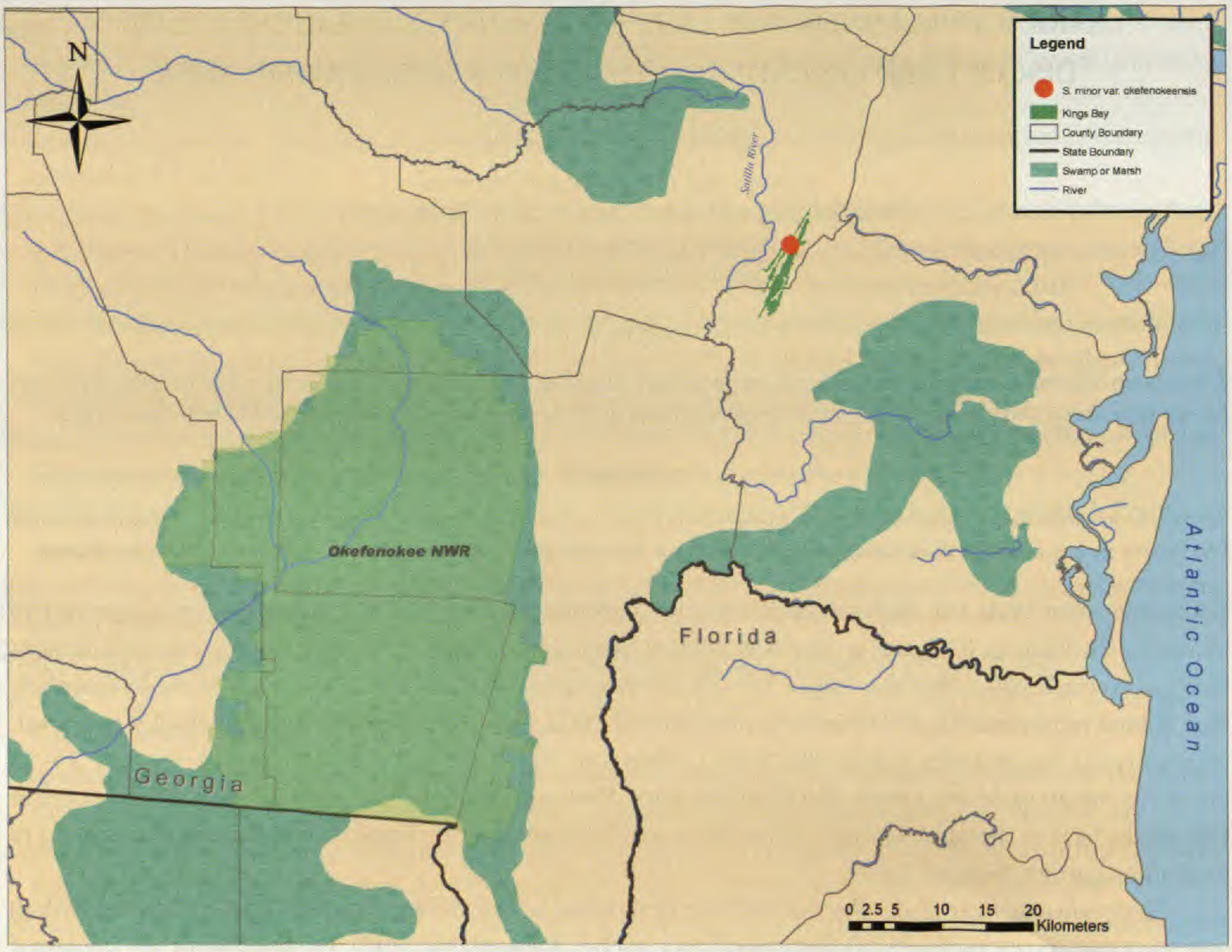

Fig. 1. Location of a *Sarracenia minor* var. *okefenokeensis* population in Kings Bay in southeast Georgia.

It should be noted that some authors do not give *S. minor* var. *okefenokeensis* taxonomic recognition. Some consider the unusual, robust morphology of plants within the Okefenokee Swamp to be ecologically induced variation that can be found across the range of *S. minor*, which stretches from North Carolina to Florida (Bell 1949; McDaniel 1966; McDaniel 1972; Mellichamp & Case 2009). However, Schnell's (2002) work disputes this. Perhaps more studies comparing the characteristics of plants in the Okefenokee Swamp and Kings Bay to those across the range of *S. minor* are necessary.

Despite the taxonomic controversy associated with *S. minor* var. *okefenokeensis*, this large population warrants future study. To those who recognize *S. minor* var. *okefenokeensis*, a study of genetic and morphological comparisons to populations within the Okefenokee Swamp may be important. Future surveys of Kings Bay are necessary to examine the limits and actual size of the *S. minor* var. *okefenokeensis* population. These surveys could also reveal new occurrences of other pitcherplant species (such as *S. psittacina*) found within the nearby Okefenokee Swamp. Furthermore, presently there is no protection for this population, as it exists on privately owned lands. This noteworthy population and its unique habitat should be considered a conservation priority in Georgia and efforts to protect Kings Bay are recommended.

ACKNOWLEDGMENTS

The author would like to thank Richard Carter at Valdosta State University for assistance with the placement of voucher specimens in the VSC herbarium. Tom Patrick assisted with the identification of *Xyris fimbriata*.

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REFERENCES

Bell, C.R. 1949. A cytotaxonomic study of the Sarraceniaceae of North America. J. Elisha Mitchell Sci. Soc. 65:137–166.

McDaniel, S.T. 1966. A taxonomic revision of *Sarracenia* (Sarraceniaceae). Ph.D. dissertation, Florida State University, Tallahassee, Florida.

McDaniel, S.T. 1971. Genus Sarracenia (Sarraceniaceae). Bull. Tall Timbers Research Station 9, Tallahassee, Florida.

Mellichamp, T.L. and F.W. Case. 2009. *Sarracenia*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Oxford University Press, New York and Oxford. 8:350–362.

Schnell, D. 2002. *Sarracenia minor* Walt. var. *okefenokeensis* Schnell: a new variety. Carniv. Pl. Newslett. 31:36–39.

Natureserve. 2010. Natureserve explorer: an online encyclopedia of life (web application) Version 7.1. NatureServe, Arlington, Virginia. Website http://www.natureserve.org/explorer [accessed: June 1, 2010]

Weakley, A.S. 2010. Flora of the Southern and Mid-Atlantic States, working draft as of March 2010. University of North Carolina, Chapel Hill, North Carolina.

BOOK REVIEW

JIM STANLEY. 2009. **Hill Country Landowner's Guide.** Louise Lindsey Merrick natural environment series, no. 44. (ISBN 978-1-603-44137-7, flexbound w/flaps). Texas A & M Press, John H. Lindsey Building, Lewis Street, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamupress.com, 1-800-826-8911). $19.95, 224 pp., 40 color photos, 1 map, 5 ½" × 8 ½".

Jim Stanley is a Texas Master Naturalist specializing in native plants and land management. He has a B.S. and M.S. in chemistry from Texas Tech and a Ph.D. from Indiana University. He retired to Kerrville after a career with Union Carbide, retiring as a senior research scientist.

In *Hill Country Landowner's Guide*, Mr. Stanley has written a complete book for natives living in or newcomers arriving in the Texas Hill Country. The Hill Country is a fragile ecosystem, and Mr. Stanley has managed to inform the reader of hazards and pitfalls, as well as actions the landowner can take to recover lost diversity.

I believe the book will be helpful to anyone living in this area. Mr. Stanley's book describes how one can measure his land so you can determine how many units of cattle can graze on your land without degrading it (I learned a unit is a cow and a calf!). There are specific instructions on how to measure the amount of appropriate plants on your land so you can determine how many animals it will support. If the land won't support your menagerie, he can tell you how much hay will be necessary to support a healthy cattle population. In addition, he provides specific steps to recover over-grazed land and notes measures that can be taken to protect the diversity of plants currently growing on the land.

One of the most helpful sections of the book deals with the various domestic and exotic animals that live in this area. Cattle, deer, horses, and feral pigs eat different plant materials—grasses, twigs, saplings, and trees. Deer and feral pigs are a real problem in this area and can pretty much destroy everything except junipers, a.k.a. cedars. Mr. Stanley suggests a couple of strategies and cautions the landowner that managing the deer population is not a one time event but an ongoing activity. Photographs of damage done by feral pigs and deer were helpful. Photographs of areas protected by fencing provide encouragement that one can recover the unique ecosystem of the Hill Country when suggestions in this book are implemented and followed with perseverance and diligence.

This book should be in the library of every landowner in the Hill Country. The information is invaluable for everyone from the new arrival with a pet cow to a veteran rancher to the person trying to save their plants from browsing deer and feral pigs.—*Kay Yount, Tarrant County Master Gardener, BRIT Volunteer, Fort Worth, Texas, U.S.A.*

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POLYCARPON TETRAPHYLLUM (CARYOPHYLLACEAE) NEW TO THE FLORA OF LOUISIANA

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ABSTRACT

Four-leaved manyseed (*Polycarpon tetraphyllum* an annual species in the Caryophyllaceae is reported new to the Louisiana flora.

RESUMEN

Polycarpon tetraphyllum es una especie anual de Caryophyllaceae que se cita como nueva para la flora de Louisiana.

Four-leaved manyseed—*Polycarpon tetraphyllum* (L.) L.—also known as four-leaved allseed, is an annual member of the Caryophyllaceae. It is characterized by mostly whorled leaves, keeled sepals 1.5–2.5 mm long, and stipules 1.8–2.8 mm long (Thieret & Rabeler 2005). The other species of *Polycarpon* in the US is California manyseed (*P. depressum* Nutt.) with opposite not whorled leaves, flat sepals 1–1.5 mm long, and stipules 0.4–1.2 mm long. Four-leaved manyseed is a native of the Mediterranean region of southern Europe and has been introduced into Ala., Calif., Fla., Ga., Ore., S.C., and Tex. in the United States and also British Columbia (Thieret & Rabeler 2005; USDA NRCS 2010). There are also historic records from Massachusetts and Pennsylvania. It is not listed for Louisiana by Thomas and Allen (1996) nor in the Plants database (USDA NRCS 2010) so our collection is apparently the first for the state.

Voucher specimens: **LOUISIANA. Vernon Parish:** equipment parking lot on Fort Polk behind Bldg 2529 off 23rd Street, 480028 3432868, 27 May 2010, *Allen et al. 21944* (BRIT, FTPK).

REFERENCES

Thieret, J.W. and R.K. Rabeler. 2005. *Polycarpon*. In: Flora of North America Committee, eds. Flora of North America north of Mexico. Vol. 5. Oxford University Press, New York. Pp. 25–26.

Thomas, R.D. and C.M. Allen. 1996. Atlas of the vascular flora of Louisiana, Vol. 2: Dicotyledons Acanthaceae-Euphorbiaceae. Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA.

USDA, NRCS. 2010. The PLANTS database (http://plants.usda.gov/plants). National Plant Data Center, Baton Rouge, LA 70874-4490.

BOOKS RECEIVED

Lane Greer and John M. Dole. 2009. **Woody Cut Stems for Growers and Florists: How to Produce and Use Branches for Flowers, Fruit and Foliage.** (ISBN 978-0-81-92892-1, hbk.). Timber Press, The Hastings Building, 133 S.W. Second Avenue, Suite 450, Portland, Oregon 97204-3527, U.S.A. (**Orders:** orders@timeberpress.com, 1-800-827-5622). $39.95, 576 pp., 137 color photos and nine line drawings, 6" × 9".

Patricia A. Harding. 2008. **Huntleyas and Related Orchids.** (ISBN 978-0-881-92884-6, hbk.). Timber Press, The Hastings Building, 133 S.W. Second Avenue, Suite 450, Portland, Oregon 97204-3527, U.S.A. (**Orders:** orders@timeberpress.com, 1-800-827-5622). 39.95, 260 pp., 150 color photos and five line drawings, 7⅜" × 10⅜".

Mary S. G. Lincoln. 2008. **Liverworts of New England: A Guide for the Amateur Naturalist.** (ISBN 978-0-893-27478-8, hbk.). Memoirs of the New York Botanical Garden, Vol. 99. The New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, New York 10458-5126, U.S.A. (**Orders:** http://nybgpress.com, nybgpress@nybg.org, 1-718-817-8721, 1-718-817-8842 fax).$45.00; 162 pp.; color photos, line drawings, and distribution maps; 7¼" × 10¼".

James W. Hinds and Patricia L. Hinds. 2007. **Macrolichens of New England.** (ISBN 978-0-893-27477-1, hbk.). Memoirs of the New York Botanical Garden, Vol. 96. The New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, New York 10458-5126, U.S.A. (**Orders:** http://nybgpress.com, nybgpress@nybg.org, 1-718-817-8721, 1-718-817-8842 fax). $65.00, 608 pp., color photos, 7⅜" × 10¼".

Charles R. Hatch. 2007. **Trees of the California Landscape.** (ISBN 978-0-520-25124-3, hbk.). University of California Press, Berkeley, California 94704, U.S.A. (**Orders:** www.ucpress.edu or California-Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, New Jersey 08618, U.S.A., 1-609-883-1759, 1-609-883-7413 fax). $60.00, 1000+ illustrations: color photos, drawings, and maps, 8⅞" × 11⅜".

Tim Robinson. 2008. **William Roxburgh: The Founding Father of Indian Botany.** (ISBN 978-1-860-77434-2, hbk.). Phillimore & Co. Ltd., Dene Road, Healey House, Andover, Hampshire, SP10 2AA, England, U.K. (**Orders:** www.phillimore.co.uk or publishing@phillimore.co.uk, 44-01264-409200). £50.00, 286 pp., 8½" × 11".

Matthew A. Jenks and Andrew J. Wood (eds). 2007. **Plant Desiccation Tolerance.** (ISBN 978-0-813-81263-2, hbk.). Wiley, 10475 Crosspoint Boulevard, Indianapolis, Indiana 46246, U.S.A. (**Orders:** www.wiley.com, 1-800-762-2974, 1-800-597-3299 fax). $209.99, 311 pp., 7" × 10½".

Peter Mickulas. 2007. **Britton's Botanical Empire: The New York Botanical Garden and American Botany, 1888–1929.** (ISBN 978-0-893-27479-5, hbk.). The New York Botanical Garden Press, 200th Street & Kazimiroff Boulevard, Bronx, New York 10458-5126, U.S.A. (**Orders:** www.nybgshop.org or customerservice@nybgshop.org, 1-718-817-8869). $45.00, 328 pp., 7" × 10.5".

Andrew Brown, Pat Dundas, Kingsley Dixon, and Stephen Hopper. 2008. **Orchids of Western Australia.** (ISBN 978-0-980-29645-7, hbk.). University of Western Australia Press, 35 Stirling Highway, Crawley, Perth, Western Australia 6009. (**Orders:** www.uwap.edu.au or admin@uwap.uwa.edu.au, 61-8-6488-3670, 61-8-6488-1027 fax). Aus. $89.95, 421 pp., 9½" × 12½".

ADDITIONS TO THE VASCULAR FLORA OF NEW MEXICO

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ABSTRACT

Documented here are 25 new state records for the vascular flora of New Mexico. These include 22 not previously reported from the state (*Botrychium hesperium*, *Botrychium lineare*, *Botrychium minganense*, *Botrychium pinnatum*, *Botrychium tunux*, *Bromus squarrosus*, *Carex microglochin* ssp. *microglochin*, *Carex nelsonii*, *Draba streptobrachia*, *Eriogonum arcuatum* var. *xanthum*, *Eriophorum scheuchzeri*, *Festuca hallii*, *Heterotheca pumila*, *Juncus alpinoarticulatus*, *Juncus biglumis*, *Juncus parryi*, *Juncus triglumis* var. *triglumis*, *Kobresia simpliciuscula*, *Listera borealis*, *Polemonium occidentale* var. *occidentale*, *Ptilagrostis porteri*, and *Rosa canina*). The remaining three, *Botrychium multifidum*, *Crataegus chrysocarpa* var. *chrysocarpa*, and *Potentilla nivea*, are confirmations of taxa reported previously without documentation.

RESUMEN

Se documentan aquí 25 nuevas citas para el estado de Nuevo México de flora vascular. Estas incluyen 22 no citadas previamente para el estado (*Botrychium hesperium*, *Botrychium lineare*, *Botrychium minganense*, *Botrychium pinnatum*, *Botrychium tunux*, *Bromus squarrosus*, *Carex microglochin* ssp. *microglochin*, *Carex nelsonii*, *Draba streptobrachia*, *Eriogonum arcuatum* var. *xanthum*, *Eriophorum scheuchzeri*, *Festuca hallii*, *Heterotheca pumila*, *Juncus alpinoarticulatus*, *Juncus biglumis*, *Juncus parryi*, *Juncus triglumis* var. *triglumis*, *Kobresia simpliciuscula*, *Listera borealis*, *Polemonium occidentale* var. *occidentale*, *Ptilagrostis porteri*, y *Rosa canina*). Las tres restantes, *Botrychium multifidum*, *Crataegus chrysocarpa* var. *chrysocarpa*, y *Potentilla nivea*, son confirmaciones de taxa citados previamente sin documentar.

New Mexico ranks fifth in geographical area and fourth in diversity of native vascular plants in the United States (Stein 2002), with Allred (2009) reporting 3,238 species. However, the cataloging of the state's flora remains incomplete. Fourteen years ago, Sivinski and Knight (1996) predicted that several hundred new state records awaited discovery in New Mexico. This has been confirmed by the 417 state records reported in the New Mexico Botanist Newsletters (http://aces.nmsu.edu/academics/rangescienceherbarium/the-new-mexico-botanist-.html) from January, 1996 to February, 2010. Documented here are 25 more additions to the state's flora. Most of these were uncovered during a floristic inventory of Vermejo Park Ranch (VPR) from 2007 to 2009 in Colfax and Taos Counties (Legler 2010). The remainder were found during field surveys in New Mexico for *Botrychium* in 2009. All specimens are deposited at the Rocky Mountain Herbarium (RM) with duplicates, where available, at the University of New Mexico Herbarium (UNM). Additional duplicates may be distributed elsewhere. Determination that a taxon is new to New Mexico is based primarily on Allred (2009), and secondarily on BONAP (2010), the USDA Plants Database (NRCS 2010), Flora of North America (FNA 1993+), and regional floras. Identifications for all cited specimens were verified by B.E. Nelson (Herbarium Manager, RM) or by specialists as listed below. Two taxa not included here, *Chionophila jamesii* Benth. and *Platanthera obtusata* (Banks ex Pursh) Lindl. ssp. *obtusata*, were recently reported as new for the state by Peterson (2010) and Heil (2009), respectively. Additional collections of these were obtained during the inventory of VPR. Their label data are available through the RM web site (Hartman et al. 2009).

ASTERACEAE

Heterotheca pumila (Greene) Semple—This endemic of subalpine and alpine habitats in Colorado, Utah, and Wyoming has been erroneously reported for New Mexico (e.g., BONAP 2010). According to Semple (2006), "Reports of occurrence of *H. pumila* from Arizona and New Mexico are based on narrow-leaved plants of *H. fulcrata* var. *amplifolia* with small ovate-lanceolate bracts subtending the heads." The collection cited here is

J. Bot. Res. Inst. Texas 4(2): 777 – 784. 2010

not *H. fulcrata* var. *amplifolia*. Its morphology matches *H. pumila*, with the leaves oblanceolate throughout and the upper leaves immediately subtending and greatly surpassing the solitary heads.

Voucher specimen: **Taos Co.:** VPR: 1.2 air mi S of Big Costilla Peak and 0.1 air mi E of point 12931, N36.90328, W105.33025, 12,542 ft elev., steep talus, scree, and rock slopes above tree line, 21 Jul 2007, *Legler 6359* (RM).

BRASSICACEAE

Draba streptobrachia R.A. Price—This species was considered endemic to the high mountains of Colorado (Al-Shehbaz et al. 2010). Verified by Ihsan Al-Shehbaz, Missouri Botanical Garden (MO).

Voucher specimen: **Taos Co.:** VPR: unnamed cirque 2.8 air mi SW of State Line Peak, N36.96351, W105.32610, 12,326 ft elev., rock pinnacle on scree slope in the alpine, 18 Jul 2009, *Legler 11463* (RM, UNM).

CYPERACEAE

Carex microglochin Wahlenb. ssp. **microglochin**—Cochrane (2003) states that this species is "usually rare to occasional in subarctic North America and scattered in the cordilleran region," where it has been documented as far south as Colorado (BONAP 2010). It is a highly distinctive but easily overlooked sedge of bogs, fens, and other peaty or wet habitats. Verified by Peter Zika, University of Washington (WTU).

Voucher specimens: **Colfax Co.:** VPR: central portion of Elk Meadows, 1 air mi NE of Little Costilla Peak, N36.83619, W105.20389, 10,850 ft elev., open fen, 29 Jul 2007, *Legler 6663* (RM, UNM); VPR: near N end of Elk Meadows, 1.1 air mi NE of Little Costilla Peak, N36.83901, W105.20400, 10,880 ft elev., hummocky fen partly shaded by *Picea*, 19 Aug 2008, *Legler 10938* (RM, UNM).

Carex nelsonii Mack.—This Rocky Mountain endemic ranges from southern Montana south to Colorado and Utah (Murray 2003). Although not previously reported from New Mexico, it has been documented from several bordering counties in Colorado (BONAP 2010). Verified by Zika.

Voucher specimen: **Taos Co.:** VPR: 0.95 air mi S of Big Costilla Peak, N36.90656, W105.32567, 12,234 ft elev., flowing snowmelt spring on gravelly alpine flat, 25 Jul 2007, *Legler 6514* (RM, UNM).

Eriophorum scheuchzeri Hoppe—Ball and Wujek (2003) report this arctic-alpine species as extending south through the Rockies to Colorado and Utah.

Voucher specimen: **Taos Co.:** VPR: unnamed ridge 2.95 air mi due N of Big Costilla Peak, N36.96282, W105.33025, 12,536 ft elev., saturated, peaty, patterned soil below a large, perennial snowfield, 21 Jul 2009, *Legler 11514* (RM, UNM).

Kobresia simpliciuscula (Wahlenb.) Mack.—This circumboreal species extends south through the Rocky Mountains to Colorado (Ball 2003). Verified by Zika.

Voucher specimens: **Colfax Co.:** VPR: central portion of Elk Meadows, 1 air mi NE of Little Costilla Peak, N36.83619, W105.20389, 10,850 ft elev., open fen, 29 Jul 2007, *Legler 6665* (RM, UNM); VPR: near N end of Elk Meadows, 1.1 air mi NE of Little Costilla Peak, N36.83899, W105.20402, 10,880 ft elev., hummocky fen partly shaded by *Picea*, 19 Aug 2008, *Legler 10939* (RM, UNM).

JUNCACEAE

Juncus alpinoarticulatus Chaix—Brooks and Clements (1993) report the distribution of this circumpolar species as extending south in the Rockies to Utah and Colorado. Verified by Zika.

Voucher specimens: **Colfax Co.:** VPR: NW shore of western-most of Bremmer Lakes in Van Bremmer Park, N36.84283, W105.09558, 8,255 ft elev., marshy meadow with alkaline influence, 1 Aug 2007, *Legler 6883* (RM, UNM); VPR: S side of Merrick Lake, 8.2 air mi WNW of Casa Grande, N36.92111, W105.11861, 8,252 ft elev., marshy lake shore, 10 Aug 2007, *Legler 7447* (RM, UNM).

Juncus biglumis L.—The cited collection represents a southern range extension of about 180 miles (290 km) from the nearest populations in Summit County, Colorado (BONAP 2010) for this circumpolar, arctic species. The plants were rare and local at this site.

Voucher specimen: **Taos Co.:** VPR: head of an unnamed cirque 2.3 air mi NNE of Big Costilla Peak, N36.95164, W105.32000, 12,533 ft elev., gravelly seep on a steep, northeast-facing, rocky, alpine slope, 20 Aug 2008, *Legler 10979* (RM, UNM).

Juncus parryi Engelm.—The previously known distribution of this species included all states in or west of the Rockies except for Arizona and New Mexico (Brooks & Clements 1993; BONAP 2010). Although it

was not previously reported for New Mexico, one small, immature specimen at UNM appears to be this species (Santa Fe Co.: Sangre de Cristo Mountains, Puerto Nambe Ridge below Pecos Baldy along Windsor Trail, T18N R11E S2 NW¼, 10,800 ft elev., 17 Jul 1997, *R. C. Sivinski 3920*). All other specimens were verified by Zika.

Voucher specimens: **Taos Co.:** VPR: ridge line 0.4 air mi SSW of Big Costilla Peak, N36.91531, W105.33058, 12,605 ft elev., rock outcrop in alpine, 25 Jul 2007, *Legler 6548* (RM); VPR: slope on SW side of Lake No. 2, 1.3 air mi SSW of State Line Peak, N36.97764, W105.30591, 11,647 ft elev., steep, northeast-facing subalpine slope with scree and talus, 17 Jul 2008, *Legler 9835* (RM, UNM).

Juncus triglumis L. var. **triglumis**—Both varieties of this primarily arctic and boreal species occur in North America. They extend south through the Rockies in scattered locations to Colorado for var. *triglumis* and New Mexico for var. *albescens* Lange Fernald (Brooks & Clements 1993; BONAP 2010). An examination of specimens at RM showed many intermediate collections, suggesting the two varieties are weakly differentiated. The most reliable characters appear to be the length of the mature capsules relative to the perianth and the shape of the mature capsule apex. Cited here are two collections clearly assignable to var. *triglumis* (*Legler 6699* and *10932*) and one intermediate specimen that appears closest to var. *triglumis* (*Legler 10986*). Verified by Zika.

Voucher specimens: **Colfax Co.:** VPR: near N end of Elk Meadows, 1.1 air mi NE of Little Costilla Peak, N36.83944, W105.20361, 10,840 ft elev., hummocky fen partly shaded by *Picea*, 29 Jul 2007, *Legler 6699* (RM, UNM); same site as previous, 19 Aug 2008, *Legler 10932* (RM, UNM). **Taos Co.:** VPR: base of a large unnamed cirque 2.5 air mi NNE of Big Costilla Peak, N36.95589, W105.31546, 11,962 ft elev., moist, subalpine meadows around seeps, 20 Aug 2008, *Legler 10986* (RM, UNM).

OPHIOGLOSSACEAE

Botrychium hesperium (Maxon & R.T. Clausen) W.H. Wagner & Lellinger—This moonwort is broadly distributed in western North America and extends south to Arizona and Colorado (Farrar 2005). It is among the more common moonworts in Colorado (S. Popovich, pers. comm.). I made 40 collections of this species in New Mexico between 2007 and 2009. Twelve of these are cited here to illustrate its distribution in the state. Data for the remaining vouchers are available through the RM web site (Hartman et al. 2009). Populations at several sites numbered in the hundreds of plants. These collections suggest the species is one of the most common moonworts in New Mexico and the lack of prior documentation may be a consequence of its cryptic nature. All collections were verified by Dr. Donald Farrar, Iowa State University (ISC), including several by enzyme electrophoresis.

Voucher specimens: **Colfax Co.:** VPR: top of "Dead Horse Hill" Mesa, 2.1 air mi NNE of Underwood Lakes and 0.3 air mi S of Colorado, N36.99001, W105.20479, 10,926 ft elev., old clear-cut, gravelly soil, with *Festuca arizonica* and young *Picea*, 7 Aug 2008, *Legler 10428* (RM, UNM); Carson National Forest, Valle Vidal Unit: near end of Forest Service Road 1913 in headwaters of Greenwood Canyon, 1.3 air mi NE of Black Mountain, N36.71162, W105.24136, 10,207 ft elev., gravelly road shoulder with *Picea* saplings, 27 Jul 2009, *Legler 11543* (RM); Colin Neblett State Wildlife Area: at junction of main access road and an abandoned side road 0.45 air mi SW of Green Mountain, N36.55631, W105.20277, 10,706 ft elev., bed of old logging road among dry *Picea* forest, 30 Jul 2009, *Legler 11566* (RM, UNM). **Rio Arriba Co.:** Santa Fe National Forest, San Pedro Parks Wilderness: along Highline Trail (#385) on N side of an unnamed tributary to Oso Creek 0.5 air mi SE of Vega del Oso, N36.10200, W106.79870, 10,289 ft elev., small subalpine meadow among *Picea* forest, 5 Aug 2009, *Legler 11592* (RM); Carson National Forest, Cruces Basin Wilderness: around a small unnamed pond 0.2 air mi NE of Brazos Ridge Overlook along Forest Service Road 87, N36.92739, W106.35326, 10,581 ft elev., rocky, hummocky, subalpine meadows with scattered *Picea*, 7 Aug 2009, *Legler 11614* (RM, UNM). **Santa Fe Co.:** Santa Fe National Forest, Santa Fe Ski Area: at junction of Desafio and Spruce Bowl runs, 0.9 air mi SE of Aspen Peak, N35.79049, W105.80018, 10,558 ft elev., north-facing ski slope with lush herbaceous cover, 31 Jul 2009, *Legler 11572* (RM, UNM). **Taos Co.:** VPR: NE shore of Beaver Lake, 3.34 air mi NE of Big Costilla Peak, N36.93497, W105.27167, 10,086 ft elev., rocky soil several feet above water line, 15 Aug 2007, *Legler 7715* (RM); VPR: logging road on N side of an unnamed tributary of Casias Creek, 1.1 air mi SE of Lake No. 2, N36.96544, W105.29011, 10,503 ft elev., gravel patch on side of road, 12 Jul 2008, *Legler 9639* (RM, UNM); VPR: near head of an unnamed stream 0.8 air mi S of Suntisteven Creek and 2.1 air mi WNW of Costilla Reservoir dam, N36.88367, W105.31783, 10,988 ft elev., old clear-cut with young *Picea*, gravelly soil, 22 Jul 2008, *Legler 9997* (RM, UNM); VPR: logging road 0.2 air mi NW of summit of Vermejo Peak, N36.89407, W105.21842, 11,050 ft elev., mesic, gravel road bed, 2 Aug 2008, *Legler 10282* (RM); Rio Costilla Park: on N side of Latir Creek 0.3 air mi NE of the lowest lake in Latir Lakes chain, N36.80662, W105.44449, 10,899 ft elev., mesic, gravelly, subalpine meadow adjacent to *Picea* forest, 27 Jul 2009, *Legler 11549* (RM, UNM); Carson National Forest, Wheeler Peak Wilderness: along trail 0.2 air mi N of outlet of Horseshoe Lake, N36.56731, W105.40456, 11,553 ft elev., steep, gravelly, subalpine meadow, 28 Jul 2009, *Legler 11553* (RM, UNM).

Botrychium lineare W.H. Wagner— Slender moonwort was previously considered for listing under the Endangered Species Act (USFWS 2001). It is widely scattered throughout boreal and western North America, usually in very small populations (Farrar 2005), but is now known to be more common than previously thought in Colorado (S. Popovich, pers. comm.). The plants cited here fit the unpublished *B. 'furcatum'*, currently considered indistinct from *B. lineare* (Farrar, pers. comm.). Forty-eight plants were counted at this site. Verified by Farrar using enzyme electrophoresis.

Voucher specimen: **Taos Co.:** Carson National Forest, Wheeler Peak Wilderness: above trail 0.23 air mi NW of outlet of Horseshoe Lake, N36.56778, W105.40586, 11,851 ft elev., steep, loose scree with *Senecio atratus* and *Cystopteris fragilis*, 28 Jul 2009, *Legler 11556* (RM, UNM).

Botrychium minganense Vict.—This widely distributed moonwort extends south throughout the western cordillera to California, Arizona, and Colorado (Farrar 2005). As with *B. hesperium*, it is among the more common moonwort species in adjacent Colorado (Popovich, pers. comm.) and has been overlooked in New Mexico. Forty-eight collections of this species were obtained in New Mexico. Thirteen of these are cited here to illustrate its distribution in the state. Data for the remaining vouchers are available through the RM web site (Hartman et al. 2009). Populations at several sites numbered in the hundreds of plants. All collections were verified by Farrar, including several by enzyme electrophoresis.

Voucher specimens: **Cibola Co.:** Cibola National Forest: 0.6 air mi SE of Mount Taylor, N35.23557, W107.59865, 10,253 ft elev., old clear-cut and subalpine spruce-fir forest with grassy openings, 3 Aug 2009, *Legler 11590* (RM, UNM). **Colfax Co.:** VPR: top of "Dead Horse Hill" Mesa, 2.1 air mi NNE of Underwood Lakes, N36.98972, W105.20347, 10,926 ft elev., old clear-cut, gravelly soil, with *Festuca arizonica* and young *Picea*, 7 Aug 2008, *Legler 10421* (RM, UNM); Carson National Forest, Valle Vidal Unit: near end of Forest Service Road 1913 in headwaters of Greenwood Canyon, N36.71461, W105.23148, 10,198 ft elev., gravelly road bank in spruce-fir forest, 27 Jul 2009, *Legler 11544* (RM); Colin Neblett State Wildlife Area: along a short spur road 0.25 air mi NW of Green Mountain, N36.56281, W105.19587, 11,014 ft elev., gravelly road bed shaded by conifers, 30 Jul 2009, *Legler 11564* (RM). **Lincoln Co.:** Lincoln National Forest, Ski Apache: on Rover Run just above where ski lift cuts across run, N33.39387, W105.80941, 11,165 ft elev., north-facing slope with cobbly soil, herbaceous cover, 2 Aug 2009, *Legler 11589* (RM, UNM). **Rio Arriba Co.:** Santa Fe National Forest, San Pedro Parks Wilderness: SW margins of Vega del Oso at head of Oso Creek, N36.10706, W106.80864, 10,414 ft elev., gravelly subalpine meadows among *Picea* forest, 5 Aug 2009, *Legler 11597* (RM); Carson National Forest, Cruces Basin Wilderness: 0.2 air mi NE of Brazos Ridge Overlook off Forest Service Road 87, N36.92739, W106.35326, 10,581 ft elev., rocky, hummocky subalpine meadows with scattered *Picea*, 7 Aug 2009, *Legler 11613* (RM). **Santa Fe Co.:** Santa Fe National Forest, Santa Fe Ski Area: on Thunderbird run, 0.1 mi north of Point 11182, N35.78730, W105.79616, 11,034 ft elev., mesic ski run with herbaceous cover, 31 Jul 2009, *Legler 11575* (RM, UNM). **Taos Co.:** VPR: logging road on S side of an unnamed tributary of Casias Creek 0.9 air mi S of Lake No. 2, N36.96616, W105.30215, 10,827 ft elev., gravelly soil on road shoulder, 12 Jul 2008, *Legler 9646* (RM, UNM); VPR: logged area 0.8 air mi S of Suntisteven Creek and 2.1 air mi WNW of Costilla Reservoir dam, N36.88336, W105.31730, 10,988 ft elev., old clear-cut with young *Picea*, gravelly soil, 22 Jul 2008, *Legler 9994* (RM); VPR: 0.3 air mi NW of summit of Vermejo Peak, N36.89618, W105.21704, 10,863 ft elev., old clear-cut on north-facing slope, 2 Aug 2008, *Legler 10239* (RM, UNM); Rio Costilla Park: Latir Lakes, camping area on NE shore of second lake, N36.80327, W105.45145, 11,142 ft elev., meadowy openings among subalpine spruce-fir forest, 27 Jul 2009, *Legler 11547* (RM); Carson National Forest, Taos Ski Area: Papa Bear Run, 0.9 air mi NNE of Kachina Peak (Point 12481), N36.57459, W105.44370, 1,683 ft elev., gravelly margins of small stream, 6 Aug 2009, *Legler 11609* (RM, UNM).

Botrychium multifidum (S.G. Gmel.) Trevis.—This widely distributed grapefern was reported from New Mexico without documentation (Martin & Hutchins 1981) as stated by Allred (2009): "Reported as expected by M&H; awaits verification." Two vouchers, verified by Farrar based on morphology, are provided here.

Voucher specimens: **Taos Co.:** VPR: S shore of third lake (from bottom) in Seven Lakes chain, 3.3 air mi E of Big Costilla Peak, N36.91100, W105.26964, 9,813 ft elev., old, drained, man-made lake bed with gravelly bottom and seeps, easily more than 1,000 plants here, 18 Aug 2007, *Legler 7915* (RM, UNM); VPR: old beaver pond in Long Canyon at W end of Seven Lakes chain, 2.6 air mi E of Big Costilla Peak, N36.91522, W105.28115, 10,056 ft elev., gravelly soil on pond margin, 16 Aug 2008, *Legler 10821* (RM, UNM).

Botrychium pinnatum H. St. John—The previously known distribution of this moonwort extended south from Alaska through the Pacific Northwest to Colorado (Farrar 2005). All collections cited here were verified by Farrar, including several by enzyme electrophoresis. At the Santa Fe Ski Area the population size was estimated at about 1,000 plants.

Voucher specimens: **Colfax Co.:** VPR: N side of an unnamed ridge 2.0 air mi due N of Underwood Lakes, N36.99070, W105.21377, 10,886 ft elev., old logging road among *Picea* forest, 11 Aug 2008, *Legler 10572* (RM). **Santa Fe Co.:** Santa Fe National Forest, Santa Fe Ski Area: Open Slope Run, 0.3 air mi NE of Point 11182, N35.78845, W105.79284, 11,011 ft elev., north-facing ski run with gravelly soil, herbaceous cover, 31 Jul 2009, *Legler 11582* (RM, UNM); Santa Fe National Forest, Santa Fe Ski Area: Little Alpine Run, 0.9 air mi SE of Lake Peak, N35.79287, W105.78688, 11,126 ft elev., rocky slope with herbaceous cover, 31 Jul 2009, *Legler 11587* (RM, UNM). **Taos Co.:** VPR: old logging road on SW side of Casias Creek 1.3 air mi SE of Lake No. 2, N36.96077, W105.28845, 10,473 ft elev., moist gravelly soil with young *Picea*, 12 Jul 2008, *Legler 9637* (RM); VPR: S side of an unnamed stream 0.9 air mi SSE of Lake No. 2, N36.96513, W105.29307, 10,614 ft elev., old clear-cut with rocky soil and *Picea* saplings, 17 Jul 2008, *Legler 9869* (RM); VPR: near head of an unnamed stream 0.8 air mi S of Suntisteven Creek and 2.15 air mi WNW of Costilla Reservoir dam, N36.88483, W105.31678, 11,034 ft elev., old clear-cut with gravelly soil and young *Picea*, 22 Jul 2009, *Legler 11524* (RM); VPR: junction of two old logging roads 1.9 air mi NW of Beaver Lakes, N36.95765, W105.28992, 10,762 ft elev., badly eroded road bed with *Picea* saplings, 19 Jul 2009, *Legler 11638* (RM).

Botrychium tunux Stensvold & Farrar—When described as new to science in 2002 (Stensvold et al.), this moonwort was assumed to be restricted to sandy, coastal beaches and alpine scree slopes in southeastern Alaska and adjacent Canada (Farrar 2005). It has since been documented from scattered locations throughout the western United States, including Colorado (Farrar, pers. comm.). In Colorado it is often found in alpine scree with *Senecio atratus* and *Cystopteris fragilis*, often in association with *B. lineare*. At the locality cited here, 35 plants were counted in just such a habitat. Verified by Farrar using enzyme electrophoresis.

Voucher specimen: **Taos Co.:** Carson National Forest, Wheeler Peak Wilderness: above trail 0.23 air mi NW of outlet of Horseshoe Lake, N36.56778, W105.40586, 11,851 ft elev., steep, loose scree with *Senecio atratus* and *Cystopteris fragilis*, 28 Jul 2009, *Legler 11555* (RM, UNM).

ORCHIDACEAE

Listera borealis Morong—The collections cited here extend the known range of this primarily boreal species south by about 160 miles (260 km) from the nearest populations in Chaffee and Gunnison Counties, Colorado (CONHP 2010). Plants were local and uncommon at both sites.

Voucher specimen: **Taos Co.:** VPR: unnamed stream 0.2 mi E of lower Twin Lake and 2.1 air mi ENE of Costilla Reservoir dam, N36.88364, W105.24444, 9,767 ft elev., cold, wet stream bottom under dense *Picea* forest, with mossy soil, 30 Jun 2007, *Legler 5324* (RM); Carson National Forest: E bank of East Fork Red River ca. 250 ft. upstream from where Trail #56 crosses river, N36.56988, W105.38226, 10,611 ft elev., mossy banks of a small, flowing stream in cool, shady *Picea* forest, 29 Jul 2009, *Legler 11558* (RM).

POACEAE

Bromus squarrosus L.—This exotic grass is well established in the northern United States and adjacent Canada (Pavlick & Anderton 2007).

Voucher specimen: **Colfax Co.:** VPR: 0.4 air mi SE of junction of Lookout Canyon and Cerrososo Canyon, 18 air mi NNW of Cimarron, N36.76436, W105.00983, 8,055 ft elev., shoulder of dirt road leading to oil well pad, 23 Jul 2007, *Legler 6432* (RM, UNM).

Festuca hallii (Vasey) Piper—The large spikelets of this grass, with the glumes equaling or slightly exceeding the lemmas, are distinctive. The species is primarily distributed in the northern Great Plains of Canada and the United States (Darbyshire & Pavlick 2007) but extends south in Colorado nearly to the New Mexico border (Snow 2008; Hartman et al. 2009; BONAP 2010).

Voucher specimen: **Taos Co.:** VPR: slope above east side of Costilla Creek ½ air mi SE of Lake No. 1, N36.97567, W105.24981, 10,240 ft elev., meadows bordered by *Populus tremuloides*, 28 Jun 2007, *Legler 5179* (RM, UNM).

Ptilagrostis porteri (Rydb.) W.A. Weber—Previously thought to be endemic to central Colorado, this species was considered for listing under the Endangered Species Act (USFWS 2005). The collection cited here represents a southern range extension of about 150 miles (240 km) from the nearest populations in El Paso County. Only a few dense clumps were observed at the location cited here. The plants were confined to the tops of mossy hummocks in a habitat similar to known occurrences in Colorado.

Voucher specimen: **Colfax Co.:** VPR: near N end of Elk Meadows, 1.1 air mi NE of Little Costilla Peak, N36.83899, W105.20400, 10,880 ft elev., hummocky fen partly shaded by *Picea*, 19 Aug 2008, *Legler 10940* (RM, UNM).

POLEMONIACEAE

Polemonium occidentale Greene var. **occidentale**—This widespread species has been documented from all states in and west of the Rockies except for New Mexico (BONAP 2010). While examining specimens at UNM, two collections of this species were found from Rio Arriba County (cited below) that had been misidentified. Additional collections from recent floristic inventories, also cited below, along with observations in the field, suggest the species is not uncommon in wet mountain meadows in the northern portion of the state.

Voucher specimens: **Colfax Co.:** VPR: headwaters of Gold Creek 1.4 air mi NW of Underwood Lakes, N36.97653, W105.22569, 11,129 ft elev., wet meadow, 18 Jul 2007, *Legler 6249* (RM, UNM); VPR: N end of Elk Meadows, 1.1 air mi NE of Little Costilla Peak, N36.83944, W105.20361, 10,840 ft elev., marshy meadow with numerous, shallow, water filled depressions and mossy tussocks, 29 Jul 2007, *Legler 6697* (RM, UNM). **Rio Arriba Co.:** Cumbres Range, wet meadows, 7 Aug 1951, *Ira M. Clark s.n.* (UNM); San Gregorio Lake, mixed collection with *P. foliosissimum*, 11 Jul 1962, *J.S. Findley s.n.* (UNM). **Taos Co.:** VPR: 0.16 mi downstream from the outlet of lower Twin Lake, 2.1 air mi ENE of Costilla Reservoir dam, N36.88583, W105.24500, 9,764 ft elev., sloping fen with stunted *Picea*, 30 Jun 2007, *Legler 5322* (RM, UNM); VPR: along Casias Creek where road to Seven Lakes crosses creek, 1.3 air mi N of north end of Costilla Reservoir, N36.91342, W105.26114, 9,577 ft elev., wet meadows, 27 Jul 2007, *Legler 6610* (RM, UNM); VPR: unnamed stream 1.6 air mi WNW of Costilla Creek Reservoir, N36.87927, W105.30833, 10,617 ft elev., sloping wet meadow in spruce-fir forest, 22 Jul 2008, *Legler 10013* (RM); VPR: between the third and fourth lakes in Seven Lakes chain in Long Canyon, 3.2 air mi ESE of Big Costilla Peak, N36.91264, W105.27038, 9,827 ft elev., wet meadow with stunted *Picea*, 19 Jul 2009, *Legler 11469* (RM); Rancho del Rio Grande Grant: along Rito de la Olla and lower Frijoles Creek, ca. ¾–1 air mi SW of Puertocito, N36.2765, W105.4119, 9,475 ft elev., moist to wet meadows and stream bank, 31 Jul 2005, *B.E. Nelson 65934* (RM).

POLYGONACEAE

Eriogonum arcuatum Greene var. **xanthum** (Small) Reveal—This showy, mat-forming buckwheat was previously considered endemic to the mountains of Colorado (Reveal 2005).

Voucher specimens: **Taos Co.:** VPR: in talus bowl 1.8 air mi S of Big Costilla Peak, N36.89408, W105.33172, 12,129 ft elev., northeast-facing, rocky, alpine slope, 19 Jul 2007, *Legler 6310* (RM, UNM); VPR: 1.2 air mi S of Big Costilla Peak and 0.1 air mi E of point 12,931, N36.90328, W105.33025, 12,542 ft elev., steep talus, scree, and rock slopes, 21 Jul 2007, *Legler 6367* (RM); VPR: 0.25 air mi NE of Big Costilla Peak, N36.92347, W105.32619, 12,172 ft elev., rocky, alpine slope, 18 Jun 2008, *Legler 8882* (RM, UNM); VPR: between 3rd and 4th lakes at Casias Lakes, 1.6 air mi S of Big Costilla Peak, N36.89698, W105.32964, 11,900 ft elev., dry, gravelly, subalpine meadow, 30 Jul 2008, *Legler 10094* (RM).

ROSACEAE

Crataegus chrysocarpa Ashe var. **chrysocarpa**—Fernald (1950) included New Mexico in the distribution of this widespread taxon, but without documentation. More recent references, particularly those of Phipps (1998), Phipps and O'Kennon (2004), and Allred (2009), omit it from the state. Three collections are provided here to confirm its presence.

Voucher specimens: **Colfax Co.:** VPR: Taber Morey Canyon 0.8 air mi W of Jones Canyon and 12 air mi WNW of Raton, N36.95049, W104.64311, 7,508 ft elev., base of rocky slope adjacent to a small, barely flowing stream, 2 Jun 2008, *Legler 8350* (RM, UNM); VPR: head of McWilliams Canyon, 13.4 air mi WNW of Raton, N36.96043, W104.66972, 7,767 ft elev., dry canyon bottom, 3 Jun 2008, *Legler 8384* (RM); VPR: McWilliams Canyon 1.8 air mi SE of Long Canyon and 14.3 air mi WNW of Raton, N36.97458, W104.68166, 7,354 ft elev., canyon bottom with barely flowing stream, 3 Jun 2008, *Legler 8387* (RM, UNM).

Potentilla nivea L.—The distribution of this circumpolar, arctic-alpine species extends south through the Rockies to Utah and Colorado (Hultén 1968; BONAP 2010). It had been reported for New Mexico only by Welsh (1982) and Welsh et al. (2003), but in both cases without documentation. Peterson (2000) questioned Welsh's report, and the species was not attributed to the state by Allred (2009). The collection cited here confirms its presence in the state.

Voucher specimen: **Taos Co.:** VPR: unnamed cirque 2.8 air mi SW of State Line Peak, N36.96413, W105.32749, 12,326 ft elev., steep, north-facing, alpine scree slope, 18 Jul 2009, *Legler 11461* (RM, UNM).

Rosa canina L.—A single large shrub was found at the site listed here. There is no evidence to suggest this shrub was planted. The species should be considered a waif in New Mexico until corroborated with further collections.

Voucher specimen: **Colfax Co.:** VPR: Left Fork York Canyon, 1.1 air mi NW of its junction with Right Fork York Canyon, N36.92083, W104.95639, 7,934 ft elev., rocky berm along a small stream on edge of revegetated coal mine spoils, bordered by forest of *Pseudotsuga menziesii* and *Abies concolor*, 8 Aug 2007, *Legler 7318* (RM, UNM).

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REFERENCES

Al-Shehbaz, I.A., M.D. Windham, and R. Elven. 2010. *Draba*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 7. Oxford University Press, New York, New York.

Allred, K.W. 2009. Flora Neomexicana I: the vascular plants of New Mexico. Published by the author (available at http://www.lulu.com/).

Ball, P.W. 2003. *Kobresia*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 23. Oxford University Press, New York, New York.

Ball, P.W. and D.E. Wujek. 2003. *Eriophorum*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 23. Oxford University Press, New York, New York.

Biota of North America Program (BONAP) 2010. U.S. county-level atlas of the vascular flora of North America. Floristic Synthesis of North America. http://www.bonap.org/MapSwitchboard.html (accessed 4 Mar 2010).

Brooks, R.E. and S.E. Clemants. 1993. *Juncus*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 22. Oxford University Press, New York, New York.

Cochrane, T.S. 2003. *Carex* sect. *Leucoglochin*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 23. Oxford University Press, New York, New York.

Colorado Natural Heritage Program (CONHP). 2010. Conservation status handbook (tracking lists). http://www.cnhp.colostate.edu/download/list.asp (accessed 31 Jan 2010). Last updated 7 Jan 2010.

Darbyshire, S.J. and L.E. Pavlick. 2007. *Festuca*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 24. Oxford University Press, New York, New York.

Farrar, D. 2005. Moonwort systematics. Ayda Hayden Herbarium, Iowa State University. http://www.public.iastate.edu/~herbarium/botrychium.html (accessed 16 Nov 2007).

Fernald, M.L. 1950. Gray's manual of botany, 8th ed. D. Van Nostrand Co., New York, New York.

Flora of North America Editorial Committee, ed. (FNA). 1993+. Flora of North America north of Mexico. Oxford University Press, New York, New York.

Hartman, R.L., B.E. Nelson, and B.S. Legler. 2009. Rocky Mountain Herbarium plant specimen database. http://www.rmh.uwyo.edu/.

Heil, K.D. 2009. *Platanthera obtusata* (Plant Distribution Report). In: New Mexico Botanist Newslett. Vol. 46. New Mexico State University, Las Cruces, NM. http://aces.nmsu.edu/academics/rangescienceherbarium/the-new-mexico-botanist-.html (accessed 10 Mar 2010).

Hultén, E. 1968. Flora of Alaska and neighboring territories. Stanford University Press, Stanford, California.

Legler, B.S. 2010. A floristic inventory of Vermejo Park Ranch, New Mexico and Colorado, M.S. Thesis, University of Wyoming, Laramie, WY.

Martin, W.C. and R.A. COLEMAN. 2003. *Listera*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 26. Oxford University Press, New York, New York.

Martin, W.C. and C.R. Hutchins. 1981. A flora of New Mexico. 2 vols. Köenigstein, Germany.

Murray, D.F. 2003. *Carex* sect. *Racemosae*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 23. Oxford University Press, New York, New York.

Natural Resources Conservation Service (NRCS). 2010. The PLANTS Database. USDA National Plant Data Center, Baton Rouge, LA. http://plants.usda.gov/ (accessed 3 Mar 2010).

Pavlick, L.E. and L.K. Anderton. 2007. *Bromus*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 24. Oxford University Press, New York, New York.

Peterson, R.S. 2000. Our alpine *Potentillas*. In: New Mexico Botanist Newslett. Vol. 16. New Mexico State University, Las Cruces, NM. http://aces.nmsu.edu/academics/rangescienceherbarium/the-new-mexico-botanist-.html (accessed 31 Oct 2007).

Peterson, R.S. 2010. *Chionophila jamesii* (Plant Distribution Report). In: New Mexico Botanist Newslett. Vol. 50. New Mexico State University, Las Cruces, NM. http://aces.nmsu.edu/academics/rangescienceherbarium/the-new-mexico-botanist-.html (accessed 5 Jun 2010).

Phipps, J.B. 1998. Introduction to the red-fruited hawthorns (*Crataegus*, Rosaceae) of western North America. Canad. J. Bot. 76:1863–1899.

Phipps, J.B. and R.J. O'Kennon. 2004. A review of *Crataegus* ser. *Rotundifoliae* (Rosaceae) in Western Canada. Sida 21:65–77.

Reveal, J.L. 2005. *Eriogonum*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 5. Oxford University Press, New York, New York.

Semple, J.C. 2006. *Heterotheca*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Vol. 20. Oxford University Press, New York, New York.

Sivinski, R.C. and P.J. Knight. 1996. Narrow endemism in the New Mexico flora. In: Southwest rare and endangered plants: Proceedings of the Second Conference. USDA Forest Servive General Technical Report RM-GTR-283.

Snow, N. 2008. Updated generic keys for Poaceae for the Southern Rocky Mountain Region. 3. *Festuca*. Aquilegia 32(2):1–3.

Stein, B.A. 2002. States of the Union: ranking America's biodiversity. NatureServe, Arlington, Virginia. http://www.natureserve.org/Reports/stateofunions.pdf (accessed 11 Mar 2010).

Stensvold, M.C., D.R. Farrar, and C. Johnson-Groh. 2002. Two new species of moonworts (*Botrychium* subg. *Botrychium*) from Alaska. Amer. Fern. J. 92:150–160.

U.S. Fish and Wildlife Service (USFWS). 6 June 2001. Endangered and threatened wildlife and plants; 12-month finding for a petition to list the plant *Botrychium lineare* (Slender Moonwort) as threatened. Fed. Reg. 66(109):30368–30372. http://ecos.fws.gov/docs/federal_register/fr3764.pdf (accessed 5 Mar 2010).

U.S. Fish and Wildlife Service (USFWS). 4 Feb 2005. Endangered and threatened wildlife and plants; 90-day finding on a petition to list *Ptilagrostis porteri* (Porter feathergrass) as Threatened or Endangered. Fed. Reg. 70(23):5959–5962. http://www.fws.gov/mountain-prairie/species/plants/feathergrass/90-dayFRnotice.pdf (accessed 11 Mar 2010).

Welsh, S.L. 1982. Utah flora: Rosaceae. Great Basin Naturalist 42:1–44.

Welsh, S.L., N.D. Atwood, S. Goodrich, and L.C. Higgens (eds.). 2003. A Utah flora, 3rd ed. Brigham Young University Press, Provo, UT.

BOOK REVIEW

VERNE HUSER. 2004. **Rivers of Texas.** (ISBN 978-1-585-44369-7, pbk.) Texas A&M University Press, John H. Lindsey Building, Lewis Street, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamupress.com, 1-800-826-8911). $16.95, 233 pp., 60 b&w photos and map of major Texas river basins, 6¼" × 9⅜".

Since the beginning of time, rivers have defined how flora, fauna, and human beings exist on earth. It is no different here in Texas, but in the words of our author it is what makes Texas rivers unique:

> Few people outside of Texas appreciate the vastness and variety offered by streams of the Lone Star state: pineywoods, bayous and moss-draped, cypress-lined steams of East Texas; spring-fed, limestone-bedded rivers of the Edwards Plateau; rain- and snow-fed perennial creeks and sandy arroyos of the Trans-Pecos mountains and the high plains; previously pirate-plied tidewater creeks, where some still believe they may find buried treasure; and the steep-walled canyons of the Rio Grande. The rivers vary from region to region, and the same river may display different characters in a trip of several hundred miles to the sea.

The author groups Texas rivers into four categories: BORDER RIVERS (Rio Grande on the south, Red River on the north, Sabine on the east), HEARTLAND RIVERS (Colorado, Brazos, Trinity), REGIONAL SPECIALTY RIVERS (the Neches of East Texas, the Nueces of South Texas, the Pecos, Canadian River of the Texas Panhandle), and INTO THE GULF OF MEXICO (those with a short course) (San Jacinto River and Buffalo Bayou, San Antonio, Lavaca and Navidad, Guadalupe).

Each river chapter also has a sidebar summarizing important information about the river including the river's general location, the source of its name, its major tributaries and recreational activities, its length, and the area of its watershed. It also includes public lands and special features. Public lands may be federal, state, or local and are listed from upstream to downstream. Features may not necessarily be protected, but they represent important association with the rivers.

To quote the author, "Texas rivers have not always been kind to Texans…." Flood stories in Texas have been legion: wide floodplains have been created by the massive amounts of water created from Texas storms. Thirty-eight inches of rain fell in a twenty-four hour period at Thrall in the San Gabriel River (Brazos) watershed of Central Texas September 9 and 10, 1921. Many Texas rivers may barely trickle during the dry season, but once inches-deep-and-wide rivers can become a mile wide when sudden 'cloudbursts' appear.

"…neither have Texans been kind to their rivers." Free flowing rivers have been altered, polluted and better known for what's been lost than for what remains. Huser points out the importance of preventing floods due to poor ecology like building in floodplains, poorly managed dams, run-off increase by human activity (from roofs, driveways, parking lots and roads, bare farm fields, and over-grazed rangelands).

In his epilogue Huser writes: "We have only recently begun to learn from modern science what Native American people have been trying to tell us for generations: that the whole earth and everything in it and on it are connected, that if we destroy one element, we impact all the others, that if we disrupt its patterns, we lose the whole."—*Linny Heagy, Linny/Designer, Illustrator, email: a0005835@airmail.net*

ANNOUNCEMENTS

2010 Delzie Demaree Travel Award Recipients

The 22nd Annual Delzie Demaree Travel Award was presented at the 57th Annual Systematics Symposium (15–16 Oct 2010) at the Missouri Botanical Garden, St. Louis. Three students were presented the Travel Award: **Aliya Donnell,** Ohio University, **Laia Barres,** The Morton Arboretum, and **Alison Scott,** University of Wisconsin-Madison.

The 2010 Travel Awards were underwritten by **1)** Delzie Demaree Travel Award Endowment, **2)** Members of the Delzie Demaree Travel Award Committee, and **3)** John Clayton Chapter of the Virginia Native Plant Society.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 500 E 4th Street, Fort Worth, TX 76102-4025, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

The 2011 Applications for the Delzie Demaree Travel Award

Applications for the 2011 Delzie Demaree Travel Award should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, Herbarium, Biology Department, The College of William and Mary, Williamsburg, VA 23187-8795; email: dmeware@verison.net. The period for receiving applications will end three weeks prior to the date of the symposium if a sufficient number of applications are in hand at that time. Anyone wishing to apply after that date should inquire whether applications are still being accepted before applying. The Systematics Symposium dates for 2011 are 7–8 October 2011.

The Delzie Demaree Travel Award was established in 1988 honoring **Delzie Demaree** who attended 35 out of a possible 36 symposia before he died in 1987. Delzie Demaree was a frontier botanist, explorer, discoverer, and teacher. His teaching career as a botanist began in Arkansas at Hendrix College in 1922. He also taught botany at the University of Arkansas, Navajo Indian School, Yale School of Forestry, Arkansas A&M, and Arkansas State University at Jonesboro where he retired as professor emeritus in 1953. One of the things he enjoyed most as a botanist was assisting students with their field botany research.

J. Bot. Res. Inst. Texas 4(2): 786. 2010

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Volume 4 (2010)

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Abbott, Richard
Amos, Bonnie B.
Anderson, Gregory
Ayers, Tina

Ballard, Jr., Harvey E.
Barkworth, Mary E.
Bayrd, Venice
Bean, A.R.
Bell, Dennis
Berg, C.C.
Block, Timothy
Brooks, Daniel R.
Brown, Larry E.
Bryson, Charles T.
Budke, Jean C.
Burke, Janelle

Calvente, Alice
Cameron, Kenneth M.
Canne-Hilliker, Judith M.
Chmielewski, Jerry G.
Clark, Lynn

Daniel, Thomas F.
Daskin, Ruziye
Delprete, Piero
Dessein, Steven
Doffitt, Chris
Downie, Stephen R.
Droissart, Vincent
Dusen, Olcay Dinc

Erika Boza Espinoza, Tatiana
Espejo-Serna, Adolfo

Felger, Richard S.
Flores Castorena, Alvaro
Floriano Barêa Pastore, José
Floyd, Jennifer W.

Gabel, Mark L.
Gandhi, Kanchi
Gandy, Elizabeth
Garcia Ruiz, Ignacio
Garcia, Miguel A.
Gelli de Faria, Ana Paula
Gil-ad, Nir L.
Ginzbarg, Steven
Giussani, Liliana M.

Haberle, Rosemarie (Romey) C.
Hartman, Ronald L.
Hatch, Stephan L.
Hawkins, Tracy S.
Hearn, David J.
Hiepko, Paul
Holmgren, Noel H.
Hrusa, Frederick
Hudnall, Wayne

Ingram, Amanda

Janovec, John
Jenks, Aaron
Jørgensen, Peter M.

Keith, Eric L.
Kirkbride, Jr., Joseph H.
Knapp, Sandra
Koopman, Margaret
Koopowitz, Harold
Krings, Alexander
Kron, Kathleen A.
Krosnick, Shawn
Kumar, E.S. Santhosh

Lammers, Thomas G.
Landrum, Leslie R.
Leong-Skornickova, Jana
Linder, H.P.
Lis, Richard
Londoño, Ximena
Lorence, David
Lowrey, Timothy K.
Lvarez Molina, Ida Beatriz

MacDougal, John
Majure, Lucas
Mayfield, Mark H.
McCauley, Ross A.
McPherson, Gordon
Mejía, Teresa
Molau, Ulf
Monfils, Anna
Motley, Timothy

Naczi, Robert F.C.
Nee, Michael
Nelle, Steve
Nelson, Allan D.
Nesom, Guy
Newman, Mark
Nickrent, Daniel L.
Noyes, Richard D.

Ocampo, Gilberto
Ode, David
Olmstead, Richard G.

Palmer, Michael W.
Patterson, Thomas
Peters, Rebecca
Peterson, Paul M.
Poole, Jackie

Rabeler, Richard
Reed, Monique D.
Reid, Christopher
Reveal, James L.
Rosen, David
Rua, Gabriel
Rúgolo de Agrasar, Zulma

Saarela, Jeffery M.
Salino, Alexandre
Salthe, Stan
Sanchez Vega, Isidoro
Schwarzbach, Andrea
Shulkina, Tatyana
Sivinski, Robert C.
Smith, Alan R.
Smith, S.G.
Smith, Selena Y.
Snow, Neil
Soreng, Robert J.
Strother, John L.

Taborsky, Edwina
Terry, Martin
Tiehm, Arnold
Tripp, Erin
Turner, Billie L.

Valdés-Reyna, Jesús
van Ee, Benjamin
Versieux, Leonardo
Villaseñor, Jose Luis

Walck, Jeff
Walsh, Neville G.
Wege, Juliet
Wendt, Tom
Whittemore, Alan T.
Williams, Justin
Wipff, Joseph
Wunderlin, Richard P.

Zika, Peter
Zomlefer, Wendy B.

Index to 85 Titles with 164 Authors: Volume 4 (2010)

We know you have a choice. Thank you for choosing and supporting *Journal of the Botanical Research Institute of Texas.*

A new combination in **Lagotis** (Plantaginaceae) by David F. Murray, Reidar Elven, and Kanchi N. Gandhi —**4(1):**219

A new combination in **Lolium perenne** (Poaceae: Poeae); **L. perenne** subsp. **stoloniferum** by Joseph K. Wipff, III—**4(2):**683

A new **Leucophyllum** (Scrophulariaceae) from Sonora, Mexico by James Henrickson and Thomas R. Van Devender—**4(2):**581

A new **Lomatium** (Apiaceae) from the Ochoco Mountains of central Oregon by Richard Helliwell—**4(1):**7

A new species of **Angelonia** (Plantaginaceae) from Mexico by Kerry Barringer—**4(1):**51

A new species of **Calceolaria** (Calceolariaceae) from disturbed paramos in south Ecuador by Pamela Puppo—**4(1):**33

A new species of **Campomanesia** (Myrtaceae) from Bahia, Brazil, based on specimens collected by J.S. Blanchet over 150 years ago by Leslie R. Landrum and Marla Ibrahim U. de Oliveira—**4(2):**603

A new varietal combination, typification, and nomenclatural comments in the Nyctaginaceae for the Intermountain flora by Richard Spellenberg—**4(1):**207

A new variety of **Bromus flexuosus** (Poaceae: Pooideae: Bromeae: sect. Bromopsis) by Ana María Planchuelo—**4(2):**653

Acronyms for recently proposed angiosperm families by Daniel L. Nickrent—**4(1):**309

Additions to the vascular flora of New Mexico by Ben S. Legler—**4(2):**777

Agalinis flexicaulis sp. nov. (Orobanchaceae: Lamiales), a new species from northeast Florida by John F. Hays—**4(1):**1

Annotated checklist of the vascular flora of the Jack Gore Baygall and Neches Bottom Units of the Big Thicket National Preserve, Tyler, Jasper, and Hardin counties, Texas by Larry E. Brown, Barbara R. MacRoberts, Michael H. MacRoberts, Warren W. Pruess, I. Sandra Elsik, and Stanley Jones—**4(1):**473

Annotated checklist of the vascular plants of Fort Hood, Texas by Laura L. Hansen—**4(1):**523

Carex oklahomensis (Cyperaceae) new to Alabama, Georgia, and Louisiana, and additional records for Mississippi by Charles T. Bryson and Paul E. Rothrock —**4(1):**347

Checklist of the vascular plants of Allegheny County, Pennsylvania by Cynthia M. Morton and Loree Speedy —**4(1):**435

Coleataenia Griseb. (1879): the correct name for **Sorengia** Zuloaga & Morrone (2010) (Poaceae: Paniceae) by Robert J. Soreng—**4(2):**691

Comments on a revision of **Celtis** subgenus **Mertensia** (Celtidaceae) and the recognition of **Celtis pallida** by James Henrickson—**4(1):**287

Congruence between allometric coefficients and phylogeny in stipoid grasses: an evo-devo study by Jack Maze—**4(2):**693

Corrigenda: the reinstatement of **Beautempsia** (Capparaceae) and a key to the genera of neotropical Capparaceae with variously stellate to peltate indumenta by Xavier Cornejo and Hugh H. Iltis—**4(1):**311

Croton bigbendensis Turner (Euphorbiaceae) revisited by James Henrickson—**4(1):**295

Diversity and abundance of orchids in a Peruvian cloud forest by Rebecca Repasky Luke, John P. Janovec, Eric Christenson, John E. Pinder III, and Keri McNew Barfield —**4(1):**317

Diversity, natural history, and conservation of **Vanilla** (Orchidaceae) in Amazonian wetlands of Madre de Dios, Peru by Ethan Householder, John Janovec, Angel Balarezo Mozambite, Javier Huinga Maceda, Jason Wells, Renan Valega, Helena Maruenda, and Eric Christenson —**4(1):**227

Erigeron mancus (Asteraceae) density as a baseline to detect future climate change in La Sal Mountain habitats by James F. Fowler and Barb Smith—**4(2):**747

First report of **Persicaria hispida** (Polygonaceae) from North America north of Mexico (Texas) by Daniel E. Atha and William Carr—**4(1):**559

Floristic composition and potential competitors in **Lindera melissifolia** (Lauraceae) colonies in Mississippi with reference to hydrologic regime by Tracy S. Hawkins, Daniel A. Skojac Jr., Nathan M. Schiff, and Theodor D. Leininger—**4(1):**381

Flourensia ilicifolia (Compositae: Heliantheae), nuevo registro para Durango y segunda zona de

distribución para la especie by M. Socorro González-Elizondo, I. Lorena López-Enriquez, José A. Villarreal Quintanilla, Jován Alemán Medrano, Jaime Sánchez Salas —**4(1):**313

Folia taxonomica 17. **Dilkea** (Passifloraceae) 2. Conspectus of the species of the Guianas with three new species by Christian Feuillet—**4(1):**55

Folia taxonomica 18. The status of **Passiflora citrifolia** and a new species in subgenus **Astrophea** (Passifloraceae), **Passiflora jussieui** by Christian Feuillet —**4(2):**609

Folia taxonomica 19. Typifications in **Dilkea** (Passifloraceae) by Christian Feuillet—**4(2):**615

Four nomenclatural changes in **Viola** (Violaceae) by R. John Little and Landon E. McKinney—**4(1):**225

Hedychium forrestii (Zingiberaceae) with a new synonymy and a variety from India by E. Sanoj, M. Sabu, and T. Rajesh Kumar—**4(2):**633

Listado florístico y aspectos ecológicos de la familia Poaceae para Chihuahua, Durango y Zacatecas, México by Yolanda Herrera Arrieta y Armando Cortés Ortiz—**4(2):**711

Miliusa wayanadica (Annonaceae), a new species from Western Ghats, India by M.K. Ratheesh Narayanan, P. Sujanapal, N. Anil Kumar, N. Sasidharan, and M. Sivadasan—**4(1):**63

Mirandea grisea (Acanthaceae), new for Coahuila and Durango, Mexico by Eduardo Estrada-Castillón, José Ángel Villarreal-Quintanilla, and Jorge Arturo Alba-Ávila —**4(2):**739

Neotypification of **Hechtia podantha** (Bromeliaceae) by Adolfo Espejo-Serna, Nancy Martínez-Correa, and Ana Rosa López-Ferrari—**4(1):**221

New names and combinations in the flora of Colorado. XIII by W.A. Weber and R.C. Wittmann—**4(1):**213

New vascular plant records for South Dakota by Gary E. Larson—**4(1):**467

Nomenclatural transfers in the genus **Myrsine** (Myrsinaceae) for New Caledonia by Jon M. Ricketson and John J. Pipoly III—**4(2):**627

Observations on **Buckleya** (Thesiaceae) in China by David E. Boufford, Chengxin Fu, Qiu-Yun (Jenny) Xiang, and Yunpeng Zhao—**4(1):**281

Occurrence of anisophylly and anisoclady within the Amaranthaceae by Donald B. Pratt and Lynn G. Clark—**4(1):**271

Paleocharis nearctica gen. and sp. nov (Cyperaceae) in Cretaceous Canadian amber by George Poinar, Jr. and David J. Rosen—**4(2):**685

Paspalum pubiflorum and **P. quadrifarium** (Poaceae) new to California, with a key and notes on invasive species by Richard E. Riefner, Jr., Silvia S. Denham, and J. Travis Columbus—**4(2):**761

Penstemon oklahomensis (Scrophulariaceae) in Texas by Jeffrey N. Mink, Jason R. Singhurst, and Walter C. Holmes—**4(1):**471

Phylogenetic analyses of the **Gaylussacia frondosa** complex (Ericaceae: Vaccinieae) based on molecular and morphological characters by Michael T. Gajdeczka, Kurt M. Neubig, Walter S. Judd, W. Mark Whitten, Norris H. Williams, and Kent D. Perkins—**4(1):**245

Planaltina nuevo género de la tribu Spermacoceae (Rubiaceae), endémico del planalto central de Brasil y una nueva especie del Estado de Goiás, Brasil by Roberto M. Salas and Elsa L. Cabral—**4(1):**193

Plant communities of selected embayments along the mid- to mid-upper Ohio River floodplain by Joseph S. Ely and Dan K. Evans—**4(1):**411

Plants new to Florida by Richard P. Wunderlin, Bruce F. Hansen, Alan R. Franck, Keith A. Bradley, and John M. Kunzer—**4(1):**349

Poa ramifer (Poaceae: Pooideae: Poeae: Poinae), a new aerially branching gynomonoecious species from Peru by Robert J. Soreng and Paul M. Peterson —**4(2):**587

Poa unispiculata, a new gynodioecious species of cushion grass from Peru with a single spikelet per inflorescence (Poaceae: Pooideae: Poeae: Poinae) by Gerrit Davidse, Robert J. Soreng, and Paul M. Peterson —**4(1):**37

Polycarpon tetraphyllum (Caryophyllaceae) new to the flora of Louisiana by Charles M. Allen, Jarrod Grandon, Krisztian Megyeri, and Brad Waguespack—**4(2):**775

Population genetic analysis of **Argemone pleiacantha** subsp. **pinnatisecta** (Sacramento Prickly Poppy, Papaveraceae) and re-evaluation of its taxonomic status by Sandy D. Cervantes, Phil Tonne, Rajanikanth Govindarajulu, Patrick J. Alexander, and C. Donovan Bailey—**4(1):**261

Potentilla uliginosa (Rosaceae: Rosoideae), a new presumed extinct species from Sonoma County, California by Barry C. Johnston and Barbara Ertter —**4(1):**13

Registro de dos nuevas localidades y reubicación de individuos de una de ellas de **Astrophytum myriostigma** (Cactaceae) en Durango, México by Jaime Sánchez Salas, Gisela Muro Pérez, Eduardo Estrada Castillón y Mario García Aranda—**4(2):**741

Rehabilitación y lectotipificación del género **Tessiera,** su relación con **Diphragmus** y **Staelia** (Rubiaceae: Spermacoceae): una nueva combinación y un nuevo sinónimo by Roberto M. Salas and Elsa L. Cabral —**4(1):**181

Revision of **Lobelia** sect. **Plagiobotrys** (Campanulaceae: Lobelioideae) by Thomas G. Lammers—**4(1):**169

Revision of **Lobelia** sect. **Speirema** (Campanulaceae: Lobelioideae) by Thomas G. Lammers—**4(1):**159

Salvia coriana sp. nov. (Lamiaceae), a new species from a cloud forest in western Guatemala by Taylor Sultan Quedensley and Mario E. Véliz Pérez—**4(1):**27

Sarracenia minor var. **okefenokeensis** (Sarraceniaceae) discovered outside of the Okefenokee Swamp area by Jacob S. Thompson—**4(2):**771

Scallopleaf sage (**Salvia vaseyi:** Lamiaceae) discovered in Arizona by James W. Cain, III, Brian D. Jansen, Richard S. Felger, and Paul R. Krausman—**4(2):**755

Studies in Capparaceae XXVII: six new taxa and a new combination in **Quadrella** by Xavier Cornejo and Hugh H. Iltis—**4(1):**75

Studies in Capparaceae XXVIII: The **Quadrella cynophallophora** complex by Hugh H. Iltis and Xavier Cornejo—**4(1):**93

Studies in the Capparaceae XXIX: synopsis of **Quadrella,** a Mesoamerican and West Indian genus by Hugh H. Iltis and Xavier Cornejo—**4(1):**117

Stylidium darwinii (Stylidiaceae), a new trigger plant from Western Ghats of Karnataka, India by Sachin A. Punekar and P. Lakshminarasimhan—**4(1):**69

Supplemental notes on Bolivian **Xyris** (Xyridaceae) by Robert Kral—**4(2):**563

Taxonomic notes on the genera **Stenotis** and **Carterella** (Rubiaceae) and transfer of **Hedyotis greenei** to **Stenotis** by Edward E. Terrell and Harold Robinson—**4(2):**619

Ten new Myrtaceae from eastern and northeastern Brazil by Marcos Sobral—**4(1):**133

The Dominican amber fossil **Lasiambix** (Fabaceae: Caesalpinioideae?) is a **Licania** (Chrysobalanaceae) by Kenton L. Chambers and George O. Poinar Jr. —**4(1):**217

The ferns and lycophytes of a montane tropical forest in southern Bahia, Brazil by Fernando B. Matos, André M. Amorim, and Paulo H. Labiak—**4(1):**333

The genus **Rytidosperma** (Poaceae) in the United States of America by Stephen J. Darbyshire, Henry E. Connor, and Barbara Ertter—**4(2):**663

The reinstatement of **Ptilimnium texense** (Apiaceae) and a new key to the genus by Mary Ann E. Feist —**4(2):**641

The vascular flora of Kerr Wildlife Management Area, Kerr County, Texas by Jason R. Singhurst, Laura L. Hansen, Jeffrey N. Mink, Bill Armstrong, Donnie Frels Jr., and Walter C. Holmes—**4(1):**497

The vascular plants of Mowotony Prairie: a small remnant coastal grassland in Brazoria County, Texas by D.J. Rosen—**4(1):**489

Thomas Walter's species of **Hedysarum** (Leguminosae) by Daniel B. Ward—**4(2):**705

Thomas Walter's species of **Melanthium** (Liliaceae) by Daniel B. Ward—**4(1):**303

Transfer of **Hedyotis intricata** to **Arcytophyllum** (Rubiaceae) by Edward E. Terrell and Harold Robinson —**4(2):**625

Two new Andean species of **Solanum** section **Crinitum** (Solanaceae) by Frank T. Farruggia, Michael H. Nee, and Lynn Bohs—**4(2):**595

Two new Bolivian species of **Aulonemia** (Poaceae: Bambusoideae: Bambuseae) by Emmet J. Judziewicz, Eddie L. Shea, and Tanya M. Wayda—**4(2):**569

Two new taxa of **Scutellaria** section **Resinosa** (Lamiaceae) from northern Arizona by S.L. Rhodes and T.J. Ayers—**4(1):**19

Typifications of names in **Agalinis, Gerardia,** and **Tomanthera** (Orobanchaceae) by J.M. Canne-Hilliker and John F. Hays—**4(2):**677

Una nueva especie de **Fevillea** (Cucurbitaceae: Zanonieae) de Costa Rica by Armando Estrada Ch. and Daniel Santamaría A.—**4(1):**45

Validation of **Exochordeae** (Rosaceae) by James L. Reveal—**4(1):**215

Vascular flora and edaphic characteristics of saline prairies in Louisiana by Christopher S. Reid, Patricia L. Faulkner, Michael H. MacRoberts, Barbara R. MacRoberts, and Marc Bordelon—**4(1):**357

Vascular flora of the Old Mulkey Meeting House State Historic Site, Monroe County, Kentucky by Ralph L. Thompson and Ronald L. Jones—**4(1):**391

Index of 164 Authors: Volume 4 (2010)

Thank you for choosing *Journal of the Botanical Research Institute of Texas.*

Alexander, Patrick J.—**4(1):**261
Allen, Charles M.—**4(2):**775
Amorim, André M.—**4(1):**333
Anil Kumar, N.—**4(1):**63
Armstrong, Bill—**4(1):**497
Arturo Alba-Ávila, Jorge —**4(2):**739
Atha, Daniel E.—**4(1):**559
Ayers, T.J.—**4(1):**19

Bailey, C. Donovan—**4(1):**261
Balarezo Mozambite, Angel —**4(1):**227
Barfield, Keri McNew—**4(1):**317
Barringer, Kerry—**4(1):**51
Bohs, Lynn—**4(2):**595
Bordelon, Marc—**4(1):**357
Boufford, David E.—**4(1):**281
Bradley, Keith A.—**4(1):**349
Brown, Larry E.—**4(1):**473
Bryson, Charles T.—**4(1):**347

Cabral, Elsa L.—**4(1):**181, 193
Cain, III, James W.—**4(2):**755
Canne-Hilliker, J.M.—**4(2):**677
Carr, William—**4(1):**559
Cervantes, Sandy D.—**4(1):**261
Chambers, Kenton L.—**4(1):**217
Christenson, Eric—**4(1):**227, 317
Clark, Lynn G.—**4(1):**271
Columbus, J. Travis—**4(2):**761
Connor, Henry E.—**4(2):**663
Cornejo, Xavier—**4(1):**75, 93, 117, 311
Cortés Ortiz, Armando—**4(2):**711

Darbyshire, Stephen J.—**4(2):**663
Davidse, Gerrit—**4(1):**37
Denham, Silvia S.—**4(2):**761

Elsik, I. Sandra—**4(1):**473
Elven, Reidar—**4(1):**219
Ely, Joseph S.—**4(1):**411
Ertter, Barbara—**4(1):**13; **4(2):**663
Espejo-Serna, Adolfo—**4(1):**221
Estrada Castillón, Eduardo—**4(2):** 739, 741
Estrada Ch., Armando—**4(1):**45
Evans, Dan K.—**4(1):**411

Farruggia, Frank T.—**4(2):**595
Faulkner, Patricia L.—**4(1):**357
Feist, Mary Ann E.—**4(2):**641
Felger, Richard S.—**4(2):**755
Feuillet, Christian—**4(1):**55; **4(2):**609; **4(2):**615
Fowler, James F.—**4(2):**747
Franck, Alan R.—**4(1):**349
Frels Jr., Donnie—**4(1):**497
Fu, Chengxin—**4(1):**281

Gajdeczka, Michael T.—**4(1):**245
Gandhi, Kanchi N.—**4(1):**219
García Aranda, Mario—**4(2):**741
González-Elizondo, M. Socorro —**4(1):**313
Govindarajulu, Rajanikanth —**4(1):**261
Grandon, Jarrod—**4(2):**775

Hansen, Bruce F.—**4(1):**349
Hansen, Laura L.—**4(1):**497, 523
Hawkins, Tracy S.—**4(1):**381
Hays, John F.—**4(1):**1; **4(2):**677
Helliwell, Richard—**4(1):**7
Henrickson, James—**4(1):**287, 295; **4(2):**581
Herrera Arrieta, Yolanda —**4(2):**711
Holmes, Walter C.—**4(1):**471, 497
Householder, Ethan—**4(1):**227
Huinga Maceda, Javier—**4(1):**227

Ibrahim U. de Oliveira, Marla —**4(2):**603
Iltis, Hugh H.—**4(1):**75, 93, 117, 311

Janovec, John P.—**4(1):**227, 317
Jansen, Brian D.—**4(2):**755
Johnston, Barry C.—**4(1):**13
Jones, Ronald L.—**4(1):**391
Jones, Stanley—**4(1):**473
Judd, Walter S.—**4(1):**245
Judziewicz, Emmet J.—**4(2):**569

Kral, Robert—**4(2):**563
Krausman, Paul R.—**4(2):**755
Kumar, T. Rajesh—**4(2):**633
Kunzer, John M.—**4(1):**349

Labiak, Paulo H.—**4(1):**333
Lakshminarasimhan, P.—**4(1):**69
Lammers, Thomas G.—**4(1):**159, 169
Landrum, Leslie R.—**4(2):**603
Larson, Gary E.—**4(1):**467
Legler, Ben S.—**4(2):**777
Leininger, Theodor D.—**4(1):**381
Little, R. John—**4(1):**225
López-Enriquez, I. Lorena —**4(1):**313
López-Ferrari, Ana Rosa—**4(1):**221
Luke, Rebecca Repasky—**4(1):**317

MacRoberts, Barbara R.—**4(1):** 357, 473
MacRoberts, Michael H.—**4(1):** 357, 473
Martínez-Correa, Nancy—**4(1):**221
Maruenda, Helena—**4(1):**227
Matos, Fernando B.—**4(1):**333
Maze, Jack—**4(2):**693
McKinney, Landon E.—**4(1):**225
Medrano, Jován Alemán—**4(1):** 313
Megyeri, Krisztian—**4(2):**775
Mink, Jeffrey N.—**4(1):**471, 497
Morton, Cynthia M.—**4(1):**435
Muro Pérez, Gisela—**4(2):**741
Murray, David F.—**4(1):**219

Nee, Michael H.—**4(2):**595
Neubig, Kurt M.—**4(1):**245
Nickrent, Daniel L.—**4(1):**309

Perkins, Kent D.—**4(1):**245
Peterson, Paul M.—**4(1):**37; **4(2):** 587
Pinder III, John E.—**4(1):**317
Pipoly III, John J.—**4(2):**627
Planchuelo, Ana María—**4(2):**653
Poinar Jr., George O.—**4(1):**217; **4(2):**685
Pratt, Donald B.—**4(1):**271
Pruess, Warren W.—**4(1):**473
Punekar, Sachin A.—**4(1):**69
Puppo, Pamela—**4(1):**33

Quedensley, Taylor Sultan—**4(1):**27

Ratheesh Narayanan, M.K.—**4(1):**63
Reid, Christopher S.—**4(1):**357
Reveal, James L.—**4(1):**215
Rhodes, S.L.—**4(1):**19
Ricketson, Jon M.—**4(2):**627
Riefner, Jr., Richard E.—**4(2):**761
Robinson, Harold—**4(2):**619, 625
Rosen, D.J.—**4(1):**489; **4(2):**685
Rothrock, Paul E.—**4(1):**347

Sabu, M.—**4(2):**633
Salas, Roberto M.—**4(1):**181, 193
Sánchez Salas, Jaime—**4(1):**313; **4(2):**741
Sanoj, E.—**4(2):**633
Santamaría A., Daniel—**4(1):**45
Sasidharan, N.—**4(1):**63
Schiff, Nathan M.—**4(1):**381
Shea, Eddie L.—**4(2):**569
Singhurst, Jason R.—**4(1):**471, 497
Sivadasan, M.—**4(1):**63
Skojac Jr., Daniel A.—**4(1):**381
Smith, Barb—**4(2):**747
Sobral, Marcos—**4(1):**133
Soreng, Robert J.—**4(1):**37; **4(2):**587, 691
Speedy, Loree—**4(1):**435
Spellenberg, Richard—**4(1):**207
Sujanapal, P.—**4(1):**63

Terrell, Edward E.—**4(2):**619, 625
Thompson, Jacob S.—**4(2):**771
Thompson, Ralph L.—**4(1):**391
Tonne, Phil—**4(1):**261

Valega, Renan—**4(1):**227
Van Devender, Thomas R.—**4(2):** 581
Véliz Pérez, Mario E.—**4(1):**27
Villarreal Quintanilla, José A.—**4(1):** 313; **4(2):**739

Waguespack, Brad—**4(2):**775
Ward, Daniel B.—**4(2):**303, 705
Wayda, Tanya M.—**4(2):**569
Weber, W.A.—**4(1):**213
Wells, Jason—**4(1):**227
Whitten, W. Mark—**4(1):**245
Williams, Norris H.—**4(1):**245
Wipff, III, Joseph K.—**4(2):**683
Wittmann, R.C.—**4(1):**213
Wunderlin, Richard P.—**4(1):**349

Xiang, Qiu-Yun (Jenny)—**4(1):**281

Zhao, Yunpeng—**4(1):**281

Botanical Names and Subject Index:

Volume 4 (2010)

New names (162) in **bold face**

Abronia
  bakeri—**4(1):**209
  crux-maltae—**4(1):**208
  robusta—**4(1):**209
Acanthaceae—**4(2):**739
Achnatherum
  hendersonii—**4(2):**696
  lemmonii—**4(2):**696
  nelsonii—**4(2):**696
  occidentale—**4(2):**696
  wallowaense—**4(2):**696
Acronyms—**4(1):**309
Agalinis—**4(2):**677
  corymbosa—**4(2):**677
  divaricata—**4(1):**5
  filifolia—**4(1):**5
  flexicaulis—**4(1):**1, 5
  laxa—**4(1):**5
  linifolia—**4(1):**5
  longifolia—**4(2):**677
  maritima var. gracilis—**4(2):**677
  maritima var. pumila—**4(2):**678
  microphylla—**4(2):**678
  obtusifolia—**4(1):**5; **4(2):**678
  palustris var. corymbosa—**4(2):** 678
  palustris var. divaricata—**4(2):** 678
  plunkenetii—**4(1):**5
  setacea var. humilis—**4(2):**678
  setacea var. major—**4(2):**678
  tenuifolia—**4(1):**5
  tenuifolia var. humilis—**4(2):** 679
  tenuifolia var. saxatilis—**4(2):**679
  virgata—**4(2):**679
Alabama—**4(1):**347
Allegheny County—**4(1):**435
Allionia
  glandulifera—**4(1):**209
  incarnata var. glabra—**4(1):**209
Allometric coefficients—**4(2):**693
Alternanthera—**4(1):**278
Amaranthaceae—**4(1):**271
Amazonian wetlands—**4(1):**227
Amber—**4(2):**685
Amianthium muscaetoxicum—**4(1):**305
Amphorogynaceae—**4(1):**309
Andean—**4(2):**595
Angelonia
  angustifolia—**4(1):**53
  biflora—**4(1):**53
  ciliaris—**4(1):**53
  gardneri—**4(1):**53
  parviflora—**4(1):**51, 53
  pilosella—**4(1):**54
Angiosperm families—**4(1):**309
Anisoclady—**4(1):**271
Anisophylly—**4(1):**271
Annonaceae—**4(1):**63

Anthospermopsis—**4(1):**195
Apera interrupta—**4(1):**467
Apiaceae—**4(1):**7; **4(2):**641
Araucaria heterophylla—**4(1):**349
Arcytophyllum—**4(2):**625
fasciculatum—**4(2):**625
Ardisia solanacea—**4(1):**350
Argemone
pinnatisecta—**4(1):**268
pleiacantha subsp. pinnatisecta —**4(1):**261
Arizona—**4(1):**19; **4(2):**755
Artemisia ludoviciana—**4(1):**350
Asteraceae—**4(1):**313; **4(2):**747
Astrophea (subg.)—**4(2):**609
Astrophytum myriostigma—**4(2):** 741
Aulonemia
boliviana—**4(2):**570
bromoides—**4(2):**570
herzogiana—**4(2):**570
longipedicellata—**4(2):**570
scripta—**4(2):**573
tremula—**4(2):**570
Azolla mexicana—**4(1):**468

Bahia—**4(1):**333; **4(2):**603
Bambuseae—**4(2):**569
Bambusoideae—**4(2):**569
Beautempsia—**4(1):**311
Big Thicket National Preserve—**4(1):**473
Blanchet, J.S.—**4(2):**603
Blutaparon—**4(1):**278
Boerhavia spicata var. torreyana—**4(1):**208
Bolivia—**4(2):**563, 569
Botrychium
hesperium—**4(2):**779
lineare—**4(2):**780
minganense—**4(2):**780
multifidum—**4(2):**780
pinnatum—**4(2):**780
tunux—**4(2):**781
Brasil—**4(1):**133, 193, 333; **4(2):**603
Brazoria County—**4(1):**489
Bromeae—**4(2):**653
Bromeliaceae—**4(1):**221
Bromopsis (Sect.)—**4(2):**653
Bromus
flexuosus—**4(2):**653
flexuosus var. famatinensis—**4(2):**655
flexuosus var. **famatinensis**—**4(2):**657
flexuosus var. flexuosus—**4(2):** 655
lanatus—**4(2):**655
modestus—**4(2):**655
squarrosus—**4(2):**781
Buckleya—**4(1):**281
angulosa—**4(1):**285
distichophylla—**4(1):**285
graebneriana—**4(1):**285
henryi—**4(1):**285
lanceolata—**4(1):**285
Butia capitata—**4(1):**350

Cactaceae—**4(2):**741
Caesalpinioideae—**4(1):**217
Calceolaria **molaui**—**4(1):**33
Calceolariaceae—**4(1):**33
California—**4(1):**13; **4(2):**761
Campanulaceae—**4(1):**159, 169
Campomanesia
blanchetiana—**4(2):**604
eugenioides—**4(2):**604
Canada—**4(2):**685
Capparaceae—**4(1):**75, 93, 117, 311
Carex
leavenworthii—**4(1):**468
microglochin—**4(2):**778
nelsonii—**4(2):**778
oklahomensis—**4(1):**347
pseudocyperus—**4(1):**468
Carterella—**4(2):**619
Caryophyllaceae—**4(2):**775
Celastrus paniculatus—**4(1):**350
Celtidaceae—**4(1):**287
Celtis
ehrenbergiana—**4(1):**289
iguanaea—**4(1):**288
subg. Mertensia—**4(1):**287
pallida—**4(1):**287
pallid var. discolor—**4(1):**292
pallid var. pallida—**4(1):**292
tala—**4(1):**291
Cervatesiaceae—**4(1):**309
Chamaelirium luteum—**4(1):**305
Chihuahua—**4(2):**711
China—**4(1):**281
Chrysobalanaceae—**4(1):**217
Cinnamomum verum—**4(1):**350
Cloud Forest—**4(1):**27, 317
Coahuila—**4(2):**739
Coleataenia—**4(2):**691
anceps—**4(2):**691
anceps subsp. **rhizomata**—**4(2):**691
caricoides—**4(2):**691
longifolia—**4(2):**691
longifolia subsp. **abscissa**—**4(2):**691
longifolia subsp. **combsii**—**4(2):**691
longifolia subsp. **elongata**—**4(2):**691
longifolia subsp. **rigidula**—**4(2):**691
petersonii—**4(2):**692
prionitis—**4(2):**692
stenodes—**4(2):692**
tenera—**4(2):**692
Colorado—**4(1):**213
Comandraceae—**4(1):**309
Compositae—**4(1):**313
Congruence—**4(2):**693
Conyza laevigata—**4(1):**350
Cordia curassavica—**4(1):**350
Corrigenda—**4(1):**311
Costa Rica—**4(1):**45
Coulaceae—**4(1):**309
Crataegus chrysocarpa var. chrysocarpa—**4(2):**782
Cretaceous Canadian amber—**4(2):**685
Crinitum (Sect.)—**4(2):**595
Croton bigbendensis—**4(1):**295
Cucurbitaceae—**4(1):**45
Curculigo capitulata—**4(1):**351
Cushion Grass—**4(1):**37
Cydista aequinoctialis—**4(1):**351
Cyperaceae—**4(1):**347; **4(2):**685
Cyperus unioloides—**4(1):**351

Desmodium
cuspidatum—**4(2):**708
glutinosum—**4(2):**707
hirta—**4(2):**708
laevigatum—**4(2):**707
lineatum—**4(2):**709
nudiflorum—**4(2):**709
paniculatum—**4(2):**709
repens—**4(2):**708
strictum—**4(2):**707
stuevei—**4(2):**708
tenuifolium—**4(2):**707
viridiflorum—**4(2):**708
Dieffenbachia seguine—**4(1):**351
Dilkea—**4(2):**615
clarkei—**4(1):**56, 61
subg. Dilkea—**4(1):**61
subg. Epkia—**4(1):**59
ercta—**4(1):**61
exilis—**4(1):**59, 61
granvillei—**4(1):**56, 61
helleborifolia—**4(2):**615
johannesii—**4(2):**615
lecta—**4(1):**61
retusa—**4(1):**59
vanessae—**4(1):**61
Dimocarpus longan—**4(1):**351
Dominican amber—**4(1):**217
Draba streptobrachia—**4(2):**778
Drynaria quercifolia—**4(1):**351
Durango—**4(1):**313; **4(2):**711, 739, 741

Ecuador—**4(1):**33
Edaphic—**4(1):**357
Embayments—**4(1):**411
Ericaceae—**4(1):**245
Erigeron mancus—**4(2):**747
Eriochloa
acuminata—**4(1):**351
villosa—**4(1):**468
Eriogonum arcuatum var. xanthum—**4(2):**782
Eriophorum scheuchzeri—**4(2):** 778
Eucalyptus camaldulensis—**4(1):** 352
Eugenia
azeda—**4(1):**133
valsuganana—**4(1):**136
Euphorbiaceae—**4(1):**295
Evo-Devo—**4(2):**693
Exochordeae—**4(1):**215

Fabaceae—**4(1):**217
Ferns—**4(1):**333
Festuca hallii—**4(2):**781
Fevillea **narae**—**4(1):**45
Flora Caroliniana—**4(2):**705
Florida—**4(1):**1, 349
Flourensia
cernua—**4(1):**314
dentata—**4(1):**314
ilicifolia—**4(1):**313, 314
microphylla—**4(1):**315
monticola—**4(1):**315
pringlei—**4(1):**315
pulcherrima—**4(1):**315
retinophylla—**4(1):**314
solitaria—**4(1):**314
Fort Hood Texas—**4(1):**523
French Guiana **4(2):**609
Froelichia—**4(1):**278

Galium circaezans—**4(1):**468
Gastrolychnis **hitchguirei**—**4(1):** 213
Gaylussacia frondosa—**4(1):**245
Georgia—**4(1):**347
Gerardia—**4(2):**677
aspera—**4(2):**680
filifolia—**4(2):**680
leucanthera—**4(2):**679
maritima—**4(2):**679
purpurea var. crassifolia—**4(2):** 680
purpurea var. parviflora—**4(2):** 680
purpurea var. paupercula—**4(2):**680
tenuifolia var. leptophylla—**4(2):**680
tenuifolia var. macrophylla—**4(2):**681
Glaux maritima—**4(1):**468
Goiás—**4(1):**193
Gomphrena—**4(1):**278
Gossypianthus—**4(1):**278
Grewia asiatica—**4(1):**352
Guatemala (Western)—**4(1):**27
Guianas—**4(1):**55, **4(2):**609

Hardin County—**4(1):**473
Hechtia podantha—**4(1):**222
Hedychium
forrestii var. forrestii—**4(2):**633, 634
forrestii var. latebracteatum—**4(2):**634
forrestii var. **pala-niense**—**4(2):**634
Hedyotis—**4(2):**619
greenei—**4(2):**619
intricata—**4(2):**625
Hedysarum—**4(2):**705
Heliantheae—**4(1):**313
Helonias bullata—**4(1):**305
Heterotheca pumila—**4(2):**777
Houttuynia cordata—**4(1):**352

India—**4(1):**63, 69; **4(2):**633
Intermountain flora—**4(1):**207
Invasive species—**4(2):**761
Iresine—**4(1):**278

Jack Gore Baygall Unit—**4(1):**473
Jasper County—**4(1):**473
Juncus
alpinoarticulatus—**4(2):**778
biglumis—**4(2):**778
parryi—**4(2):**778
triglumis var. triglumis—**4(2):** 779

Karnataka—**4(1):**69
Kentucky—**4(1):**391
Kerr County—**4(1):**497
Kerr Wildlife Management Area—**4(1):**497
Kobresia simpliciuscula—**4(2):**778

La Sal Mountains—**4(2):**747
Lagotis
glauca subsp. glauca—**4(1):**219

glauca subsp. **lanceolata**—**4(1)**:220
Lamiaceae—**4(1)**:19, 27; **4(2)**:755
Lamiales—**4(1)**:1
Lauraceae—**4(1)**:381
Lechea stricta—**4(1)**:468
Leguminosae—**4(2)**:705
Leucophyllum
hintonorum—**4(2)**:584
mojinense—**4(2)**:581
Licania **dominicensis**—**4(1)**:217
Liliaceae—**4(1)**:303
Lindera melissifolia—**4(1)**:381
Lipocarpha micrantha—**4(1)**:468
Listera borealis—**4(2)**:781
Lobelia
borneensis—**4(1)**:173
borneensis subsp. borneensis—**4(1)**:173
borneensis subsp. **celebensis**—**4(1)**:174
borneensis subsp. **grandiflora**—**4(1)**:176
borneensis subsp. **insulae-florum**—**4(1)**:174
deleiensis—**4(1)**:162
fangiana—**4(1)**:162
longipedicellata—**4(1)**:162
montana—**4(1)**:162
origenes—**4(1)**:177
sect. **Plagiobotrys**—**4(1)**:172
sect. **Speirema**—**4(1)**:161
Lobelioideae—**4(1)**:159, 169
Lolium
perenne—**4(2)**:683
perenne subsp. **stoloniferum**—**4(2)**:683
Lomatium
ambiguum—**4(1)**:11
canbyi—**4(1)**:10
cous—**4(1)**:11
gormanii—**4(1)**:10
hambleniae—**4(1)**:11
henersonii—**4(1)**:11
leptocarpum—**4(1)**:11
ochocense—**4(1)**:7, 10
piperi—**4(1)**:11
rollinsii—**4(1)**:11
roseanum—**4(1)**:11
watsonii—**4(1)**:11
Louisiana—**4(1)**:347, 357; **4(2)**:775
Lumnitzera racemosa—**4(1)**:352
Lycophytes—**4(1)**:333

Madre de Dios—**4(1)**:227
Melanthium—**4(1)**:303
virginicum—**4(1)**:305
Mesoamerica—**4(1)**:117
Mexico—**4(1)**:51, 313; **4(2)**:581, 711, 739, 741
Microteaceae—**4(1)**:309
Miliusa **wayanadica**—**4(1)**:64
Mimusops coriacea—**4(1)**:352
Mirandea grisea—**4(2)**:739
Mississippi—**4(1)**:347, 381
Mitracarpus—**4(1)**:195
Monotropa uniflora—**4(1)**:468
Mowotony Prairie—**4(1)**:489
Myrcia
crassa—**4(1)**:138
floridissima—**4(1)**:140
mucugensis—**4(1)**:142
pendula—**4(1)**:145
pseudomarlierea—**4(1)**:147
pseudospectabilis—**4(1)**:150
tetraphylla—**4(1)**:152
Myrsinaceae—**4(2)**:627
Myrsine—**4(2)**:627
albiflorens—**4(2)**:628
arborea—**4(2)**:628
asymmetrica—**4(2)**:628
asymmetrica subsp. **magnifolia**—**4(2)**:628
asymmetrica subsp. **paniensis**—**4(2)**:628
asymmetrica subsp. **parvifolia**—**4(2)**:628
belepensis—**4(2)**:629
boulindaensis—**4(2)**:629
citrifolia—**4(2)**:629
diminuta—**4(2)**:629
discocarpa—**4(2)**:629
dumbeaensis—**4(2)**:629
grandifolia—**4(2)**:629
humboldtensis—**4(2)**:629
katrikouensis—**4(2)**:629
koghiensis—**4(2)**:629
kuebiniensis—**4(2)**:629
lanceolata subsp. **ouenarouensis**—**4(2)**:629
lecardii—**4(2)**:629
macrophylla—**4(2)**:629
macrophylla subsp. **menaziensis**—**4(2)**:630
mcphersonii—**4(2)**:630
memaoyaensis—**4(2)**:630
modesta—**4(2)**:630
modesta subsp. **coriaria**—**4(2)**:630
modesta subsp. **tiebaghiensis**—**4(2)**:630
munzingeri—**4(2)**:630
nigricans—**4(2)**:630
nigricans subsp. **ouinensis**—**4(2)**:630
nitens—**4(2)**:630
novocaledonica—**4(2)**:630
novocaledonica subsp. **balabioensis**—**4(2)**:630
novocaledonica subsp. **boulindaensis**—**4(2)**:630
novocaledonica subsp. **kaalaensis**—**4(2)**:630
novocaledonica subsp. **mueoensis**—**4(2)**:630
novocaledonica subsp. **piroguensis**—**4(2)**:630
oblanceolata—**4(2)**:630
oblanceolata subsp. **doensis**—**4(2)**:631
obovalifolia—**4(2)**:631
ouameniensis—**4(2)**:631
ouazangouensis—**4(2)**:631
ovicarpa—**4(2)**:631
paniensis—**4(2)**:631
parvicarpa—**4(2)**:631
parvicarpa subsp. **amossensis**—**4(2)**:631
parvicarpa subsp. **pachyphylla**—**4(2)**:631
poumensis—**4(2)**:631
pronyensis—**4(2)**:631
spissifolia—**4(2)**:631
stenophylla—**4(2)**:631

taomensis—**4(2):**631
tchingouensis—**4(2):**631
verrucosa—**4(2):**631
verrucosa subsp. **microphylla**—**4(2):**631
yateensis—**4(2):**632
Myrtaceae—**4(1):**133
Myrtaceae—**4(2):**603

Najas minor—**4(1):**469
Nanodeaceae—**4(1):**309
Neches Bottom Unit—**4(1):**473
New Caledonia—**4(2):**627
New Mexico—**4(2):**777
Nuttallia **rhizomata**—**4(1):**213
Nyctaginaceae—**4(1):**207

Ochoco Mountains—**4(1):**5
Ohio—**4(1):**411
Ohio River—**4(1):**411
Okefenokee Swamp Area—**4(2):**771
Old Mulkey Meeting House State Historic Site—**4(1):**391
Orchidaceae—**4(1):**227, 317
Oregon—**4(1):**5
Oreocarya revealii—**4(1):**213
Orobanchaceae—**4(1):**565; **4(2):**677
Oxybaphus glaber—**4(1):**208

Paleocharis—**4(2):**686
nearctica—**4(2):**687
Paniceae—**4(2):**691
Papaveraceae—**4(1):**261
Paramos—**4(1):**33
Paspalum—**4(2):**761
dilatatum—**4(2):**767
distichum—**4(2):**767
notatum—**4(2):**767
notatum var. saurae—**4(2):**767
pubiflorum—**4(2):**761, 767
quadrifarum—**4(2):**761, 767
urvillei—**4(2):**767
vaginatum—**4(2):**767
Passiflora—**4(2):**609
cardonae—**4(2):**613
cauliflora—**4(2):**613
cerradensis—**4(2):**613
citrifolia—**4(2):**609
jussieui—**4(2):**611, 613
maguirei—**4(2):**613
skiantha—**4(2):**613
Passifloraceae—**4(1):**55; **4(2):**609, 615
Pennsylvania—**4(1):**435
Penstemon oklahomensis—**4(1):**471
Pentas lanceolata—**4(1):**353
Persicaria hispida—**4(1):**559
Peru—**4(1):**37, 227, 317; **4(2):**587
Pfaffia—**4(1):**278
Philodendron hederaceum—**4(1):**353
Pimenta dioica—**4(1):**353
Pithecellobium bahamense—**4(1):**353
Planaltina—**4(1):**193, 195, 198
capitata—**4(1):**199
lanigera—**4(1):**202
myndeliana—**4(1):**204
Plant communities—**4(1):**411
Plantaginaceae—**4(1):**51, 219
Plinia **espinhacensis**—**4(1):**156
Poa
ramifer—**4(2):**587
unispiculata—**4(1):**37
Poaceae (checklist)—**4(2):**711
Poaceae—**4(1):**37; **4(2):**569, 587, 653, 663, 683, 691, 761
Poeae—**4(1):**37; **4(2):**587, 683
Poinae—**4(1):**37, 587
Polemonium occidentale var. occidentale—**4(2):**782
Polyalthia suberosa—**4(1):**353
Polycarpon tetraphyllum—**4(2):**775
Polygonaceae—**4(1):**559
Pooideae—**4(1):**37; **4(2):**587, 653
Potentilla
nivea—**4(2):**782
uliginosa—**4(1):**14
Ptilagrostis porteri—**4(2):**781
Ptilimnium
capillaceum—**4(2):**648
costatum—**4(2):**646, 648
nuttallii—**4(2):**648
texense—**4(2):**641, 648
Purshia tridentata—**4(1):**469

Quadrella
alaineana—**4(1):**75, 129
angustifolia—**4(1):**129
antonensis—**4(1):**125
asperifolia—**4(1):**125, 126
subg. **Breyniastrum**—**4(1):**121, 124
calciphila—**4(1):**125, 126
cynophallophora—**4(1):**93
cynophallophora f. **linearifolia**—**4(1):**98, 122
domingensis—**4(1):**129
domingensis subsp. domingensis—**4(1):**129
domingensis subsp. **grisebachii**—**4(1):**129
dressleri—**4(1):**77, 125
ferruginea—**4(1):**130
ferruginea subsp. **cubensis**—**4(1):**129, 130
ferruginea subsp. ferruginea—**4(1):**129
filipes—**4(1):**125, 126
gonaievensis—**4(1):**104, 121
incana subsp. incana—**4(1):**80, 129
incana subsp. **yucatanensis**—**4(1):**83, 129
incana var. **triangularis**—**4(1):**80, 129
indica—**4(1):**125, 126
subg. **intutis**—**4(1):**121, 128
isthmensis—**4(1):**107, 122
isthmensis subsp. **glabripetala**—**4(1):**111, 123
isthmensis subsp. **mexicana**—**4(1):**110, 1123
jamaicensis—**4(1):**98, 121, 123
jamaicensis f. **longifolia**—**4(1):**98
lindeniana—**4(1):**83, 125
lundellii—**4(1):**125, 127
mirifica—**4(1):**125, 127
morenoi—**4(1):**86, 125

morenoi f. **hastata**—**4(1):**90
odoratissima—**4(1):**123
pringlei—**4(1):**125
pringlei—**4(1):**127
subg. Quadrella—**4(1):**121
quintanarooensis—**4(1):**104, 121
siliquosa—**4(1):**98, 121
singularis—**4(1):**129, 131
steyermarkii—**4(1):**125, 128

Radermachera sinica—**4(1):**353
Rosa canina—**4(2):**782
Rosaceae—**4(1):**13, 215
Rousselia humilis—**4(1):**353
Rubiaceae—**4(1):**181, 193; **4(2):** 619, 625
Rytidosperma—**4(2):**663
biannulare—**4(2):**665
caespitosum—**4(2):**665
penicillatum—**4(2):**665
racemosum—**4(2):**665
richardsonii—**4(2):**665

Sacramento Prickly Poppy—**4(1):** 261
Saline prairies—**4(1):**357
Salvia
cinnabarina—**4(1):**27
coriana—**4(1):**27
curtiflora—**4(1):**28
excelsa—**4(1):**28
hispanica—**4(1):**28
holwayi—**4(1):**28
polystachya—**4(1):**28
purpurea—**4(1):**28
tiliaeifolia—**4(1):**28
vaseyi—**4(2):**755
Santalaceae—**4(1):**281
Sarracenia
minor—**4(2):**771
minor var. okefenokeensis—**4(2):**771
Sarraceniaceae—**4(2):**771
Scallopleaf sage—**4(2):**755
Scrophulariaceae—**4(1):**471; **4(2):** 581
Scutellaria
platyphylla—**4(1):**24
platyphylla var. grahamiana—**4(1):**26
platyphylla var. kaibabensis—**4(1):**26
platyphylla var. **occidentalis**—**4(1):**24
platyphylla var. occidentalis—**4(1):**24
platyphylla var. platyphylla—**4(1):**24
platyphylla var. tessellata—**4(1):**26
potosina—**4(1):**24
potosina var. **kaibabensis**—**4(1):**20
Senna atomaria—**4(1):**354
Solanaceae—**4(2):**595
Solanum
adenobasis—**4(2):**598
cyathophorum—**4(2):**596
umbellatum—**4(1):**354
Sonoma Couinty—**4(1):**13
Sonora—**4(2):**581
Sorengia—**4(2):**691
South Dakota—**4(1):**467
Spermacoceae—**4(1):**181, 193
Staelia—**4(1):**195
State Records
Arizona—**4(2):**755
California—**4(2):**761
Louisiana—**4(2):**775
New Mexico—**4(2):**755
South Dakota—**4(1):**467
Texas—**4(1):**471, 559
Stellaria parva—**4(1):**354
Stenotis—**4(2):**619
arenaria—**4(2):**620
asperuloideds—**4(2):**620
australis—**4(2):**620
brevipes—**4(2):**620
gracilenta—**4(2):**621
greenei—**4(2):**622
mucronata—**4(2):**620
Stipoid grasses—**4(2):**693
Strombosiaceae—**4(1):**309
Stylidiaceae—**4(1):**69
Stylidium
darwinii—**4(1):**69, 72, 75
kunthii—**4(1):**73
tenellum—**4(1):**73

Tessiera—**4(1):**195
hexasepala—**4(1):**184, 189
lanigera—**4(1):**191
lithospermoides—**4(1):**186
pubescens—**4(1):**190
Texas—**4(1):**471, 473, 489, 497, 523, 559
Thesiaceae—**4(1):**281, 309
Thomas Walter—**4(1):**303
Tidestromia—**4(1):**278
Tofieldia racemosa—**4(1):**305
Tomanthera lanceolata—**4(2):**677, 679
Trema orientalis—**4(1):**34
Trichosanthes cucumerina—**4(1):**354
Triplaris melaenodendron—**4(1):**354
Tripterocalyx carneus var. **pedunculatus**—**4(1):**207
Tyler County—**4(1):**473

United States of America—**4(2):**663
Utah—**4(2):**747

Vaccinieae—**4(1):**245
Vanilla—**4(1):**227
bicolor—**4(1):**230
cristato-callosa—**4(1):**230
guianensis—**4(1):**230
palmarum—**4(1):**230
pompon subsp. grandiflora—**4(1):**230
riberoi—**4(1):**230
Viola
epipsila var. **repens**—**4(1):**225
pedatifida var. **brittoniana**—**4(1):**225
praemorsa var. **flavovirens**—**4(1):**225
sororia var. **grisea**—**4(1):**226
Violaceae—**4(1):**225
Walter, Thomas—**4(2):**705

West Indies—**4(1):**117
Western Ghats—**4(1):**63, 69
Wissadula amplissima—**4(1):**355

Ximeniaceae—**4(1):**309

Xyridaceae—**4(2):**563
Xyris
  crassifunda—**4(2):**563
  rigida—**4(2):**566
  submetallica—**4(2):**565
  vacillans—**4(2):**566

Zacatecas—**4(2):**711
Zanonieae—**4(1):**45
Zigadenus glaberrimus—**4(1):**305
Zingiberaceae—**4(2):**633

162 New Names and New Combinations: Volume 4 (2010)

Agalinis flexicaulis Hays, sp. nov.—**4(1):**1
Angelonia parviflora Barringer, sp. nov.—**4(1):**51
Arcytophyllum fasciculatum (A. Gray) Terrell & H. Rob., comb. nov.—**4(2):**625
Argemone pinnatisecta (G.B. Ownbey) S.D. Cervantes & C.D. Bailey, comb. et stat. nov.—**4(1):**268
Aulonemia
  bromoides Judz. & Shea, sp. nov.—**4(2):**570
  scripta Judz. & Wayda, sp. nov.—**4(2):**573

Bromus flexuosus Planchuelo var. **famatinensis** Planchuelo, var. nov.—**4(2):**657

Calceolaria molaui Puppo, sp. nov.—**4(1):**33
Campomanesia blanchetiana Landrum & Ibrahim, sp. nov.—**4(2):**604
Coleataenia
  anceps (Michx.) Soreng, comb. nov.—**4(2):**691
  anceps subsp. **rhizomata** (Hitchc. & Chase) Soreng, comb. nov.—**4(2):**691
  caricoides (Nees ex Trin.) Soreng, comb. nov.—**4(2):**691
  longifolia (Torr.) Soreng, comb. nov.—**4(2):**691
  longifolia subsp. **abscissa** (Swallen) Soreng, comb. nov.—**4(2):**691
  longifolia subsp. **combsii** (Scribner & C.R. Ball) Soreng, comb. nov.—**4(2):**691
  longifolia subsp. **elongata** (Scribn.) Soreng, comb. nov.—**4(2):**691
  longifolia subsp. **rigidula** (Bosc ex Nees) Soreng, comb. nov.—**4(2):**691
  petersonii (Hitchc. & Ekman) Soreng, comb. nov.—**4(2):**692
  prionitis (Nees) Soreng, comb. nov.—**4(2):**692
  stenodes (Griseb.) Soreng, comb. nov.—**4(2):**692
  tenera (Beyr. ex Trin.) Soreng, comb. nov.—**4(2):**692

Dilkea
  clarkei Feuillet, sp. nov.—**4(1):**56
  exilis Feuillet, sp. nov.—**4(1):**59
  granvillei Feuillet, sp. nov.—**4(1):**56

Eugenia
  azeda Sobral, sp. nov.—**4(1):**133
  valsuganana Sobral, sp. nov.—**4(1):**136
Exochordeae Schulze-Mentz ex Reveal, trib. nov.—**4(1):**215

Fevillea narae A. Estrada & D. Santamaría, sp. nov.—**4(1):**45

Gastrolychnis hitchguirei (Bocquet) W.A. Weber & R.C. Wittmann, comb. nov.—**4(1):**213

Hedychium forrestii var. **palaniense** Sanoj & M. Sabu, var. nov.—**4(2):**634

Lagotis glauca subsp. **lanceolata** (Hultén) D.F. Murray & Elven stat. nov.—**4(1):**220
Leucopyllum mojinense Henrickson & T.R. Van Devender, sp. nov.—**4(2):**581
Licania dominicensis (Poinar, K.L. Chambers & A.E. Brown) K.L. Chambers & Poinar, comb. nov.—**4(1):**217
Lobelia
  borneensis subsp. **celebensis** Lammers, subsp. nov.—**4(1):**174
  borneensis subsp. **grandiflora** (Stapf) Lammers, comb. et stat. nov.—**4(1):**176
  borneensis subsp. **insulae-florum** Lammers, subsp. nov.—**4(1):**174
  origenes Lammers, sp. nov.—**4(1):**177
  sect. **Plagiobotrys** Lammers, sect. nov.—**4(1):**172
  sect. **Speirema** (Hook. f.) Lammers, comb. nov.—**4(1):**161
Lolium perenne subsp. **stoloniferum** (C. Lawson) Wipff, comb. et stat. nov.—**4(2):**683
Lomatium ochocense Helliwell & constance ex Helliwell, sp. nov.—**4(1):**7

Miliusa wayanadica Sujanapal, Ratheesh & Sasidharan, sp. nov.—**4(1):**64
Myrcia
  crassa Sobral, sp. nov.—**4(1):**138
  floridissima Sobral, sp. nov.—**4(1):**140
  mucugensis Sobral, sp. nov.—**4(1):**142
  pendula Sobral, sp. nov.—**4(1):**145
  pseudomarlierea Sobral, sp. nov.—**4(1):**147
  pseudospectabilis Sobral, sp. nov.—**4(1):**150
  tetraphylla Sobral, sp. nov.—**4(1):**152
Myrsine
  albiflorens (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**628
  arborea (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**628

asymmetrica (Mez) Ricketson & Pipoly, comb. nov.—**4(2):**628
asymmetrica subsp. **magnifolia** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**628
asymmetrica subsp. **paniensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**628
asymmetrica subsp. **parvifolia** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**628
belepensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**629
boulindaensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**629
citrifolia (Mez) Ricketson & Pipoly, comb. nov.—**4(2):**629
diminuta (Mez) Ricketson & Pipoly, comb. nov.—**4(2):**629
discocarpa (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**629
dumbeaensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**629
grandifolia (S. Moore) Ricketson & Pipoly, comb. nov.—**4(2):**629
humboldtensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**629
katrikouensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**629
koghiensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**629
kuebiniensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**629
lanceolata subsp. **ouenarouensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.
lecardii (Mez) Ricketson & Pipoly, comb. nov.—**4(2):**629
macrophylla (Mez) Ricketson & Pipoly subsp. **menaziensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**630
macrophylla (Mez) Ricketson & Pipoly, comb. nov.—**4(2):**629
mcphersonii (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**630
memaoyaensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**630
modesta (Mez) Ricketson & Pipoly, comb. nov.—**4(2):**630
modesta subsp. **coriaria** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**630
modesta subsp. **tiebaghiensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**630
munzingeri (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**630
nigricans (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**630
nigricans subsp. **ouinensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**630
nitens (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**630
novocaledonica (Mez) Ricketson & Pipoly, comb. nov.—**4(2):**630
novocaledonica subsp. **balabioensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**630
novocaledonica subsp. **boulindaensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**630
novocaledonica subsp. **kaalaensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**630
novocaledonica subsp. **mueoensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**630
novocaledonica subsp. **piroguensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**630
oblanceolata (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**630
oblanceolata subsp. **doensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**631
obovalifolia (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
ouameniensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
ouazangouensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
ovicarpa (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
paniensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
parvicarpa (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
parvicarpa subsp. **amossensis** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**631
parvicarpa subsp. **pachyphylla** (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**631
poumensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
pronyensis (Guillaumin) Ricketson & Pipoly, comb. nov.—**4(2):**631
spissifolia (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
stenophylla (Mez) Ricketson & Pipoly, comb. nov.—**4(2):**631
taomensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
tchingouensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
verrucosa (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**631
verrucosa subsp. microphylla (M. Schmid) Ricketson & Pipoly, comb. et stat. nov.—**4(2):**631
yateensis (M. Schmid) Ricketson & Pipoly, comb. nov.—**4(2):**632

Nuttallia rhizomata (Reveal) W.A. Weber & R.C. Wittmann, comb. nov.—**4(1):**213

Oreocarya revealii W.A. Weber & R.C. Wittmann, nom. nov.—**4(1):**213

Paleocharis Poinar & D.J. Rosen, gen. nov.—**4(2):**686
nearctica Poinar & D.J. Rosen, sp. nov.—**4(2):**687
Passiflora jussieui Feuillet, sp. nov.—**4(2):**611

Planaltina R.M. Salas & E.L. Cabral, gen. nov.—**4(1):**198
capitata (K. Schum.) R.M. Salas & E.L. Cabral, comb. nov.—**4(1):**199
lanigera (DC.) R.M. Salas & E.L. Cabral, comb. nov.—**4(1):**202
myndeliana R.M. Salas & E.L. Cabral, sp. nov.—**4(1):**204
Plinia espinhacensis Sobral, sp. nov.—**4(1):**156
Poa
ramifer Soreng & P.M. Peterson, sp. nov.—**4(2):**587
unispiculata Davidse, Soreng & P.M. Peterson, sp. nov.—**4(1):**37
Potentilla uliginosa B.C. Johnston & Ertter, sp. nov.—**4(1):**14

Quadrella
alaineana Cornejo & Iltis, sp. nov.—**4(1):**75
angustifolia (Kunth) Iltis & Cornejo, comb. nov.—**4(1):**129
antonensis (Woodson) Iltis & Cornejo, comb. nov.—**4(1):**125
asperifolia (K. Presl) Iltis & Cornejo, comb. nov.—**4(1):**126
subg. **Breyniastrum** (DC.) Iltis, comb. nov.—**4(1):**124
calciphila (Standl. & Steyerm.) Iltis & Cornejo, comb. nov.—**4(1):**126
cynophallophora f. **linearifolia** Iltis, f. nov.—**4(1):**98
domingensis (Spreng. ex DC.) Iltis & Cornejo, comb. nov.—**4(1):**129
domingensis subsp. **grisebachii** (Eichler) Iltis & Cornejo, comb. nov.—**4(1):**129
dressleri Cornejo & Iltis, sp. nov.—**4(1):**77
ferruginea (L.) Iltis & Cornejo, comb. nov.—**4(1):**130
ferruginea subsp. **cubensis** (R. Rankin) Iltis & Cornejo, comb. nov.—**4(1):**130
filipes (Donnell Smith) Iltis & Cornejo, comb. nov.—**4(1):**126
incana subsp. **yucatanensis** (Lundell) Iltis, comb. et stat. nov.—**4(1):**83
incana var. **triangularis** Cornejo & Iltis, var. nov.—**4(1):**80
indica (L.) Iltis & Cornejo, comb. nov.—**4(1):**126
subg. **Intutis** (Raf.) Iltis, comb. et stat. nov.—**4(1):**128
isthmensis subsp. **glabripetala** Cornejo & Iltis, subsp. nov.—**4(1):**111
isthmensis subsp. **mexicana** Cornejo & Iltis, subsp. nov.—**4(1):**110
jamaicensis f. **longifolia** (Sw.) Iltis, comb. et stat. nov.—**4(1):**98
lindeniana Cornejo & Iltis, sp. nov.—**4(1):**83
lundellii (Standl.) Iltis & Cornejo, comb. nov.—**4(1):**127
mirifica (Standl.) Iltis & Cornejo, comb. nov.—**4(1):**127
morenoi Cornejo & Iltis, sp. nov.—**4(1):**86
morenoi f. **hastata** Iltis, f. nov.—**4(1):**90
pringlei (Briquet) Iltis & Cornejo, comb. nov.—**4(1):**127
quintanarooensis Iltis & Cornejo, sp. nov.—**4(1):**104
siliquosa (L.) Iltis & Cornejo, comb. nov.—**4(1):**98
singularis (R. Rankin) Iltis & Cornejo, comb. nov.—**4(1):**131
steyermarkii (Standl.) Iltis & Cornejo, comb. nov.—**4(1):**128

Salvia coriana Quedensley & Véliz, sp. nov.—**4(1):**27
Scutellaria
platyphylla var. **occidentalis** S. Rhodes & T. Ayers, var. nov.—**4(1):**24
potosina var. **kaibabensis** S. Rhodes & T. Ayers, var. nov.—**4(1):**20
Solanum
adenobasis M. Nee & Farruggia, sp. nov.—**4(2):**598
cyathophorum M. Nee & Farruggia, sp. nov.—**4(2):**596
Stenotis greenei (A. Gray) Terrell & H. Rob., comb. nov.—**4(2):**622
Stylidium darwinii Punekar & Lakshmin., sp. nov.—**4(1):**69

Tessiera hexasepala (Borhidi & Lozada) R.M. Salas & E.L. Cabral, comb. nov.—**4(1):**184
Tripterocalyx carneus var. **pedunculatus** (M.E. Jones) Spellenb., comb. nov.—**4(1):**207

Viola
epipsila var. **repens** (Turcz. ex Trautv. & C.A. Mey.) R.J. Little, stat. nov.—**4(1):**225
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praemorsa var. **flavovirens** (Pollard) R.J. Little, stat. nov.—**4(1):**225
sororia var. **grisea** (Fernald) L.E. McKinney, comb. nov.—**4(1):**226

Xyris
crassifunda Kral, sp. nov.—**4(2):**563
submetallica Kral, sp. nov.—**4(2):**565

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